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Abstracts

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# JAPANESE JOURNAL OF ENGINEERING

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Vol. 1

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Page	Line	For	Read
4	8 from bottom	stiffening trusses	stiffening trusses.
"	4 " "	diagonal cables	diagonal cables.
"	Bottom	P	P
9	4	efficiency	efficiency
"	5 from bottom	$C = .065 R^{1.4}$	$C = 0.065 R^{1.4}$
13	7 " "	state lines railways	state lines of railways
15	Heading	<i>Civil Engineeing</i>	<i>Civil Engineering</i>
18	18	Tohihisa	Toshihisa
20	12	temperatuee	temperature
"	8 from bottom	a function of the distance $x$	$\xi$ , a function of the distance $x$
23	10	mkg/cm <sup>3</sup>	m-kg/cm <sup>3</sup>
28	20	deck plating to beam	deck plating to beam,
29	16	V shaped	V-shaped
34	Bottom	in rease	increase
35	3	596	396
"	7	mtallic	metallic
40	9 from bottom	<b>Triodes</b> Hideji	<b>Triodes.</b> Hideji
42	6 " "	utilization	utilization
43	13	Japanese).	(Japanese).
50	2 from bottom	<i>earthed.</i>	<i>earthed</i> (Japanese).
51	2	valtage	voltage
"	13	$\frac{1}{2\pi\sqrt{cL}}$	$\frac{1}{2\pi\sqrt{C L}}$
"	19 from bottom	1st. part	1st part
"	18 " "	2nd. part	2nd part
"	17 " "	3rd. pard	3rd part
"	13 " "	1st.,	1st,
"	12 " "	2nd.,	2nd,
59	8 " "	Tetsu-to Hagane	Tetsu-to-Hagane



## CIVIL ENGINEERING (1-63).

1. *Tidal Current in the Shimonoseki Strait* (Japanese). Kyojiro ICHINOSE. [J. Civ. Eng. Soc., VII., 5 (1921), 783-815, with fig., map and table]—It is a well known fact that a tidal wave in passing a narrow strait undergoes considerable reduction in the velocity of its propagation. In order to estimate this velocity at the Strait of Shimonoseki, harmonical analyses of the establishments, spring and neap rises, and neap ranges at two different sections taken across the main channel were made with the following results:

Table I.—Tidal Ranges and Establishments.

Stations	Establishment (Hr. Min.)	Spring Rise (Shaku.)	Neap Rise (Sh.)	Neap Range (Sh.)	Longitude	Diff. of Time (Min.)	$\theta$ (Hr. Min.)
Hesaki	IX 5'	14.00	8.75	3.50	131° 11'12"E	- 0.24	IX 4.76
Myojinbana	„ 19'	9.75	6.50	3.00	130° 57'35"E	0.00	„ 19.00
Deshimaehi	„ 42'	6.92	4.51	2.11	„ 55'28"E	+ 0.12	„ 42.12
Tanokubi	„ 48'	6.34	4.03	1.71	„ 54'52"E	+ 0.18	„ 48.18
Haidomari	„ 59'	5.50	3.50	1.25	„ 52'18"E	+ 0.36	„ 59.36

$\theta$ =the interval between the time of high water at any given section and the time of moon's passing the meridian of Myojinbana. For location of the stations see the Hydrographic Chart issued by the Admiralty.

From these results, the changes in the velocity of propagation of tidal wave in the channel, have been calculated as shown in the following table:

Table II.—Velocity of Propagation of Tidal Wave.

Station	$\theta$	Difference (min.)	Distance (Ken=5.97 ft.)	Vel. of Propag. (Ft. per sec.)
Hesaki	IX 4.76			
Myojinbana	„ 19.00	14.24	3,300	23.17
Deshimaehi	„ 42.12	23.12	2,740	11.85
Tanokubi	„ 48.18	6.06	1,200	19.80
Haidomari	„ 59.36	11.18	3,850	34.26

The tables show (1) that the difference of the establishments at Hesaki and Haidomari, amounting to 54 minutes, is caused by the difference of the distances through

which tidal waves travel on each side of the Kynshu Island, so that the establishment at Hesaki at the east entrance is earlier than that at Haidomari at the west entrance, (2) that, in consequence, the tide propagates with less speed from the east entrance towards the west, the speeds varying at the successive stations, (3) that the establishments at the five stations arranged in order beginning at the eastern end of the strait are successively retarded, and (4) that the amplitude of tide is greatest at Hesaki, the east entrance, gradually diminishing towards Haidomari the west entrance, where it is smallest.

The tide gauge records show that the tide in the channel is influenced by conditions of the outside sea, and only when the latter is tranquil—a case seldom met with,—the tide curves in the channel approach the sinnsoids. These facts clearly show that the tide in this channel is solely due to the tidal wave propagating itself from east to west, and also that the gradual diminution of tidal amplitude gives rise to the velocity head of the tidal current.

As to the amounts of the tidal fluctuation and the velocity of the current, series of long continued observations have shown (1) that the velocity of current gradually increases towards high and low water, and owing to the difference of amplitudes of tide in the channel, eastward flow continues while the stage of tide is below the mean sea-level, (2) that the flow practically ceases when the mean sea-level is reached, at which the westward one commences, which continues as long as the tidal stage remains above the mean sea-level. To be more exact the tidal stage at which the current turns lies within very close limits above and below the mean sea-level. Any deviation from these rules is due to the weather conditions obtaining at the time.

As a rule, easterly winds raise the water level at the east entrance, and depress that at the west entrance; while westerly winds bring about the contrary results. In consequence a westerly wind accelerates the reversal of the westward flow for the ebb and retards that of the eastward flow; while an easterly wind acts in the opposite way, and the eastward flow makes its turn at the stage lower than the mean sea-level.

An attempt is made to derive a new velocity formula for the unsteady flow developed in the channel. The author shows that the velocity of the tidal current in the channel is proportional to the square root of the product of the height of water surface with respect to the mean sea-level by the depth of water at the section considered. Thus:

$$V_m = C\sqrt{Dh} \quad (1)$$

in which  $V_m$ =mean velocity at any instant in the section considered,  $D$ =the stage of tide at the instant with respect to m.s.l.,  $h$ =the total depth and  $C$ =the velocity coefficient.

The reliability of this formula was put to test at the Tanokubi section. Current diagrams were drawn on a plan, giving the positions, and mean velocities of floats and the instants at which the floats passed the section. The mean velocity corresponding to the total vertical depth was obtained by using Francis' empirical formula:

$$V_m = V'_m \left( 1.012 - 0.116 \sqrt{\frac{h-h'}{h}} \right) \quad (2)$$

where  $V'_m$ =velocity of float in shaku per second and  $h'$ =length of float submerged in water in shaku.

Substituting in equation (1) the value of  $V_m$  in (2) and obtaining the expression for the velocity coefficient, a diagram was plotted with  $D$  as the abscissa and  $C$  as the ordinate. The diagram has shown that  $C$  varies directly with the square root of  $h$ . Denoting the



vertical distance of the point where the locus of  $C$  cuts the vertical axis by  $\alpha$  and the tangent of the inclination of the locus by  $\beta$

$$C = \alpha + \beta\sqrt{D} \quad (3)$$

for which the diagram gives  $\alpha=0.176$  and  $\beta=0.217$ , so that for Tanokubi Section

$$C=0.176+0.217\sqrt{D} \quad (4)$$

By a similar process the following formula is obtained for the Myojinbana section

$$C=0.084+0.212\sqrt{D} \quad (5)$$

The maximum current velocity does not occur at Myojinbana, but it is found at some distance beyond the place. On an average, the maximum velocity was found to be 1.20 times greater than that observed at the Myojinbana section. For the mean current velocity in an entire section the following formula is given:

$$V = C\sqrt{D.H} \quad (6)$$

in which  $V$ =mean velocity and  $H$ =hydraulic mean depth.

By using the equations (1) and (6), the velocities of current developed at different stages of tide in the Shimonoseki Strait may be readily obtained. Author.

**2. A New Formula for the Velocity of Unsteady Flow in an Open Channel (Japanese).** Kyojiro ICHINOSE. [J. Civ. Eng. Soc., VII., 5 (1921), 817-831, with diag.]-In this, the formulae given in the preceding paper, viz.  $V=C\sqrt{D.H}$ ,  $C=\alpha+\beta\sqrt{D}$  are put into forms, which are applicable to all cases of unsteady flow, with the exception of two cases: (1) When an unsteady flow is due to more than two sources, as in the case of tidal compartment of a tidal river (2) When the channel is one connecting a lagoon with the sea.

The data on which the new formula is based are those obtained from long-continued observations made in the Kitakami River, one of the largest rivers in Japan. The observations were made at a point about 25 miles from the river mouth, quite a distance above the tidal compartment.

Assuming that the horizontal line passing through the deepest point of the section considered, corresponds to the mean sea-level of the previous case, the following values of coefficient  $C$  have been obtained from numerous discharge observations:

For small floods (in August) .....	0.225
Ditto (in June, at falling stages) .....	0.205
For high floods (in April, July and October) .....	0.226
For low-water stage .....	0.234
For the mean .....	0.225

It was found that  $C$  is generally somewhat larger for all stages when the river is rising.

Making  $C$  a constant,  $C=\alpha=.225$

The flood in this river which often rise more than 20 ft., present conditions similar to those observed at the Shimonoseki Strait in so far as the decrease of  $\beta$  or the increase of  $\alpha$  is followed by the decrease of depth below the standard level.

Putting  $C=2C_0-\alpha$  and  $\beta\sqrt{D}=2(C_0-\alpha)$  and

denoting by  $D'$ ,  $C'$  and  $\alpha'$  the respective quantities at a given stage,  $\frac{\sqrt{D'}}{\sqrt{D}} = \sqrt{\frac{C'-C}{C_0-\alpha}}$

For  $\alpha'=0$   $\beta'=0.464$  and for  $\alpha'=0.225$ ,  $\beta'=0$

It was found after a number of trials that under normal conditions  $\alpha$  varies as the square of the ratio of depths at high and low water. Denoting by  $H_o$  the depth below the standard level

$$\alpha = C_o \left( \frac{H_o - D}{H_o + D} \right)^2$$

If the bed coincides with the low water level,  $H_o$  would be equal to  $D$ , making  $\alpha=0$ . On the other hand, if it rises to the standard level,  $H_o$  would vanish, so that  $\alpha=C_o$  which is the case with musteady flow in one direction only.

In an open channel, with a flow only in one diredction,  $C$  may be found by actual gauging when the flow is practically constant, or by the use of the well-known formula,

$$V_o = \varphi \sqrt{S_o H_o}$$

in which  $S_o$ =slope,  $V_o$ =mean velocity,  $H_o$ =hydraulic mean depth and  $\varphi$ =constant given in text books.

The author's formula for this case is

$$V_o = C_o \sqrt{D_o H_o} \text{ in which } C_o = \varphi \sqrt{\frac{S_o}{D_o}} \quad \text{Author.}$$

**3. On the Vibration of Suspension Bridges** (Japanese). Nagaho MONO-NOBE. [J. Civ. Eng. Soc., VII, 4 (1921), 561-604, with fig.]—The following formulas are worked out for the use in calculating the free vibration periods in various types of suspension bridges, and their reliability is shown from the results of actual measurements.

1. Period of vertical vibration of a cable suspension bridge without stiffening trusses.

$$T = 0.6 \left( 1 + \frac{h^2}{l^2} \right) \frac{l^2}{h} \sqrt{\frac{m}{AE}}$$

where  $T$ =vibration period in seconds,  $l$ =length of central span,  $h$ =sag,  $m$ =mass of the bridge per unit length,  $A$ =total sectional area of the cables and  $E$ =modulus of elasticity of the cables.

2. Ditto, with stiffening trusses

$$T = 0.6 l^2 \sqrt{\frac{1}{\frac{h^2 AE}{m} + \frac{9 IE}{8m} + \frac{0.3604}{h}}}$$

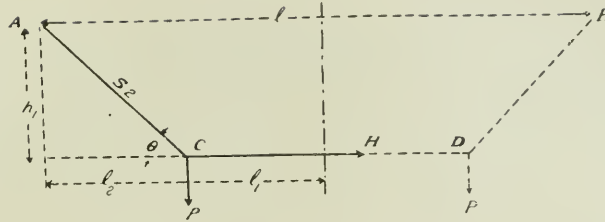
in which  $I$ =moment of inertia of the stiffening trusses,  $E$ =modulus of elasticity of the truss material.

3. Ditto, with stiffening trusses and diagonal cables

$$T = 0.6 l^2 \sqrt{\frac{1}{\frac{h^2 AE}{m} + \frac{9 IE}{m} + 0.09 \left( \frac{h_1 l^2}{\pi} \right)^2 \left\{ \sum \frac{g A_2 E_2}{P} \cdot \frac{1}{\left( S_2^3 + \frac{l l_2^2}{2} - l_2^3 \right)} + \sum \frac{g A_2 E_2}{P} \cdot \frac{1}{S_2^3} \right\}}}$$

where  $A_2$  and  $E_2$  are sectional area and modulus of elasticity of each diagonal cable respectively, and  $h_1$ ,  $s_2$ ,  $l_2$  and  $P$  are as shown in the annexed figure.





4. Period of lateral vibration of a cradled suspension bridge without lateral trusses.

$$T = 2\pi \sqrt{\frac{L}{g} \left\{ \cos \alpha + \frac{4x^2 I^2}{b^2} \right\}}$$

where  $L$  = vertical distance of the centre of gravity of the bridge from the towers,  $\alpha$  = inclination of the cable to the vertical plane,  $I^2$  = mass moment of inertia of the bridge about the center line of support plane divided by the mass of the bridge and  $b$  = width of the bridge floor.

The formula shows that the cradling furnishes but little lateral stiffness.

5. Period of lateral vibration of a suspension bridge with horizontal stiffening truss.

$$T = \frac{2}{\pi} l^2 \sqrt{\frac{1}{\frac{l EI}{M} + \left(\frac{l}{\pi}\right)^4 \frac{g}{\alpha}}}$$

where  $E$  = modulus of elasticity of the material of the horizontal stiffening truss,  $I$  = moment of inertia,  $M$  = total mass of the central span.

Light suspension bridges often constructed on country roads in Japan are easily set in vibration by the passing loads, and their free vibrations may be observed when they are un-loaded. Generally, the vibration period of a light and long span is too long to harmonize with the pace of troops. It was found that in case the period of vertical vibration is greater than 0.8 second, the impact due to the vibration would never exceed 20% of the moving loads.

Author.

4. *On the Efficiency of Steam-Hammer Pile Driver* (Japanese). Shigeyuki KANAMORI. [J. Civ. Eng. Soc., VII., 3 (1921), 453-472, with fig.]—The loss of energy caused by back pressure of steam is expressed by the following formula:

$$E_L = \frac{\sqrt{2g} A^2 l}{ca} \sqrt{\frac{p_0}{P_0}} \left[ \frac{P_0 - p}{2} + \frac{A}{16W} - \left( 4p^2 - P_0^2 - 3P_0 p \right) + \left( \log \frac{\sqrt{p}}{\sqrt{P_0} + \sqrt{P_0 - p}} \right)^2 \left( \frac{P}{2} - \frac{11}{16} \frac{Ap^2}{W} \right) \right]$$

in which  $E_L$ , the loss of energy due to back pressure;  $W$ ,  $l$  and  $A$ , the weight, the stroke and the sectional area of the cylinder, respectively;  $a$ , the sectional area of the exhaust orifice of the cylinder;  $c$ , the coefficient depending on the form and size of the orifice;  $P_0$  and  $p_0$  the initial pressure and density of the steam at the moment the weight begins to fall;  $p$ , the atmospheric pressure; and  $g$ , the acceleration of gravity.

Applying this formula to the results of a trial made with Lacour's steam-hammer, it was found that  $E_L = 70.73$  ft. lb., amounting to 1.3% of the total energy expended in driving.

By driving piles with the same steam-hammer, operating alternately by steam and man-power, otherwise under precisely the same conditions, and comparing the results, the loss of energy, when operated by steam, was found to be 4.16 % on an average.

In order to find the influence of the speed of blows on the penetration of a pile, Lacour's steam-hammer was operated first at the speed of one blow every two sec., and then at one blow every ten sec. on the same pile. The result was that the mean penetration per blow at the greater speed exceeded that at the lesser one by 1 to 4.3 %, and in mean 17.8 % of the lower amount. These facts lead to the following conclusions:—

(A) The efficiency of a steam hammer is less than that of a drop-hammer, when driven at equal speed, due to the back pressure of the residual steam during its descent.

(B) The efficiency of a steam-hammer worked at its proper speed is higher than that of a drop-hammer by reason of its quicker blows; this fact outweighs the drawback stated under (A).

The formula for the bearing power of a pile driven with a steam-hammer is  $P=f\left[\frac{(Wh-E_L)d}{1.3}\right]$ ; while that for one driven with a drop-hammer takes the form  $P=f[Whd]$ ;  $P$ ,  $h$ , and  $d$  designating bearing power, height of fall and last penetration, respectively, and the other designations being as stated above. The reliability of these formulas is shown by applying them to the results of tests, and comparisons are drawn with other formulæ in use. Author.

**5. On the Economical Slope for Power Canals (Japanese).** Bunji MATSUDA. [J. Civ. Eng. Soc., VII., 4 (1921), 651-658, with fig.]—For a power canal with definite sectional form and dimensions, considering the slope as a variable, the author has deduced formulas for determining the most economical slope. Examples are calculated for two kinds of tunnel sections and one of open channels. For a tunnel cut in soft rock, and with rectangular section  $d$  in depth,  $1.2d$  in width, and spanned by a circular arch  $0.3d$  in rise, and provided with a lining of concrete  $0.1d$  in thickness, all expressed in ft. he gives:

$$S=\left\{\frac{(12.073 C_e+3.083 C_l) k}{C Q^{\frac{1}{5}} C_v^{\frac{4}{5}}}\right\}^{\frac{5}{7}}$$

in which  $S$ =economical slope,  $C_e$ =cost of excavation and  $C_l$ =cost of lining, both in yen per cu. ft.,  $k$ =annual rate of charges on the capital,  $C$ =value of power developed in yen per kw-t,  $Q$ =water used in cu. ft. and  $C_v$ =coefficient of velocity.

The formulæ for other sections are also given and an example is worked out for each case.

**6. The Result of Borings at the Site for the Proposed Tunnel under the Shimonozeaki Strait (Japanese).** Kikumatsu HIRAI. [J. Civ. Eng. Soc., VII., 4 (1921), 605-638, with fig. and phot.]—The Strait at the site of the proposed tunnel is about a mile in width. The boring operations were carried on under exceptional difficulties, owing to the rapid current which runs alternately in opposite directions at every turn of the tide. The borings were made at ten places, of which six were on the land and four in water, along the center line of the tunnel. Craelius' core drill was used for the purpose, operating the machine from a specially designed movable trestle. The depth of water at the deepest point was 40 feet. The trestle was built in three sections, which when put together measured, 69 ft. 10 in. in height. The upper section was a steel frame with a height of 50 ft.; the middle one formed four air tanks, while the lowest section, which was built of reinforced concrete, served as a base 40 ft. square and 4 ft. high. When the tanks were filled with compressed

air the trestle drew twenty feet of water and easily towed, but when the air in the tanks was replaced by sea-water the trestle sunk down to the bottom.

The borings were driven to depths of 100 to 150 ft. below the low water surface. It was found that, for about 1,000 ft. from the Honshyu side, the bottom consists of indurated clay and sand, containing large amount of gravels and boulders as far as the borings reached. For the next 2,300 ft. hard detrital rocks were met, while for the rest of the strait width the bottom was found to be of sand of unknown depth.

Author.

**7. *On the Flow of Water at the Inlet and Outlet of a Water Course, with Special Reference to River Mouth*** (Japanese). Noboru YAMAGUTI. [J. Civ. Eng. Soc., VII., 5 (1921), 911-984, with fig.]—By using the usual method of the conformal projection of the conjugate functions of the complex variables a formula is established for the stream lines between two convergent partitions. The formula agrees with that obtained by Harris and published in *Annals of Mathematics* 1:00-1901. Applying the formula to the flow at the South-West Pass of the Mississippi River, observed by Lipsey during the floods of 1914-17, the author finds that, instead of taking the whole plane of the stream lines, some central portion drawn to a proper scale might be used. Combining the stream line formula with the friction-slope formula obtained by Coriolis and Boussinesq, expressions for the surface slope at the inlet, and for that at the outlet are obtained. Further, the aspects of the formation of bars and deltas at the mouths of non-tidal rivers are studied.

Author.

**8. *Stability of Bridge Piers and Abutments with Foundations built in Soft Ground*** (Japanese). Mitsuo NAWA. [J. Civ. Eng. Soc., VII., 1 (1921), 35-54, with diag. and fig.]—The bridge over the River Ibi on the Kwansai Line has a length of 3,260 ft. and is situated near the mouth of the river. It consists of 15 spans of 200 ft.—Warren girders, and 1 span of 120 ft.—Pratt truss. The bottom of the river is of silt with occasional streaks of shells, throughout the whole width of the river, and down to the depth 150 ft. The river is 3 to 5 ft. in depth at low-water, although in some places a depth of 18 ft. is found, caused by the scouring action of the tide.

The foundations for the piers are of elliptical brick wells, 30 ft. by 15 ft. sunk to depths of from 50 to 90 ft. below the low-water mark; and in some of them pine piles of 24 ft. in length were driven within the wells. When the wells were sunk, test-loads (1,200 tons each) were applied on them, which caused them to continue sinking until the test-loads were removed. On concreting the bottom of the wells, the test loads were again laid on them, by which the wells sank from 17 to 27 ft. or more and then stood still for some time. At this stage the test-loads were removed and the wells filled with concretes, leaving in each two shafts 5 ft. in diameter. Piers of brick works with stone facing, 19 ft. in height were then built on these wells. The piers themselves were also made hollow with the object of reducing their weight.

It was an open question among the engineers who were in charge of the work to what extent the piers constructed in such loose soil, without reaching any firm ground, would sink in course of time. Twenty-five years have elapsed since the construction; the traffic passed during that period amounted to 43,000,000 tons, while the axle load of locomotives enormously increased from that first used, and yet the sinking of the piers is found not to have exceeded 0.03 to 0.72 ft. In other words, the piers have retained practically the same heights as those observed at the time of testing. It is a rather remark-

able fact that deeper wells have shown greater amounts of sinking, from which it will be seen that the depths of wells in the ground do not necessarily increase their supporting power.

Author.

#### 9. *Improvement of the Liao River under International Organization.*

Bunkichi OKAZAKI. [J. Civ. Eng. Soc., VII., 5 (1921), 758-781, with pl.]—The Liao River has a drainage area of 60,000 sq. miles. The river has been an important commercial waterway in Manchuria and Mongolia for centuries. The navigable reach of the Liao is divided into two sections according to the kind and size of crafts navigating the river. The first section is 350 miles in length, extending from the river mouth to Chengchiatun; while the second section covers the distance from the latter up to Tungliachen, a length of 150 miles. The lower section is used by vessels with a carrying capacity of about 15 tons, and a draft of  $2\frac{1}{2}$  ft., while the upper section is available only for crafts drawing not more than 6 inches.

The improvement work is mainly aimed at the regulation of the lower reach. Investigations have shown that while the most common obstacles to navigation are the bars, the greatest trouble is caused by the diversion canals which draw large amounts of water in dry seasons for irrigation purposes. Canalization, which alone makes for radical improvement, is entirely out of question owing to its enormous cost. The construction of reservoirs for impounding the surplus water against the scarcity in dry seasons is recommendable. On the other hand, as floods cause no small amounts of damages, owing to their volumes, and as the meagre embankments are built solely by the riparian communities, it is necessary to teach those people a rational method of levee construction. At the same time, further investigations regarding the flood discharge and the extent of the inundated territories are greatly required. A canal to connect the Liao with the Sungari is considered desirable not only for the purpose of navigation, but also for the supply of water in the Liao. For improving the main river, dredging is now being carried on, though not quite to the extent desired. Several short-cuts are proposed and necessary investigations therefore are being carried on.

Author.

#### 10. *On Secondary Stresses in the Lateral System of a Trussed Bridge*

(Japanese). Juichiro NAKAHARA. [J. Civ. Eng. Soc., VII., 1 (1921), 109-116, with fig.]—The paper discusses the secondary stresses produced in diagonals of the lateral system (double diagonal type) of a trussed bridge, and results thereof on stresses in the main truss members. The secondary stresses are divided into two kinds, viz: (1) Those possible to be eliminated by due care in the construction (2) Those not so possible. The latter kinds are the results from the deformations of the chord members of the main truss; their amounts are generally too great to be overlooked, especially when caused by strong winds, or other horizontal forces at the bridge under full load. When the chord members of the main truss are strained, the diagonals of the lateral system are necessarily called into action, and in consequence they have their resistance against lateral forces proportionately reduced. In other words, the effective sectional areas of the diagonal members become considerably less than the total net areas, giving rise to what may be called "efficiency of lateral members" from the viewpoint of their original purpose. The discussion leads to the following conclusions: (1) That diagonals of the lateral system of a trussed bridge receive the same kind of stresses as do the main chords to which they belong, and that the stresses caused by lateral loads in two diagonals of a panel may be regarded to be



equal. (2) That diagonals of the lateral system of a trussed bridge may in part be regarded as forming a portion of the main chords to which they belong. (3) That the proportioning of diagonals of the lateral system of a trussed bridge must take into consideration their efficiency which mainly depends on the ratio of the distance between trusses to panel length.

Author.

**11. Yield of Rivers at Reservoir Sites in Chosen** (Japanese). Seijiro MATSUI. [J. Civ. Eng. Soc., VII., 6 (1921), 1119-1124 with diag. and table.]—The low-water discharge of rivers in Chosen (Korea) is very small compared with that in Japan, varying from 0.1 to 0.5 cub. ft. per sec. per square mile of their basins and therefore not amounting to more than  $\frac{1}{10}$  of that in the latter country. On the contrary, maximum flood discharge in summer is greater than that in Japan, exceeding 1,500 cub. ft. per sec. for the first square mile. For this reason, in planning water supply, irrigation and power works, the question of reservoirs presents itself as one of great moment.

This paper gives the results of run-off observations made at the reservoirs in Fusan and Chinnampo together with those made at the irrigation reservoir of the Model Farm at Suigen, for more than five years. The water sheds of the streams running into these reservoirs are but sparsely wooded with young pines. From careful observations made on the fluctuations of water surfaces in these reservoirs, and after making due allowances for evaporation and percolation, the following results have been obtained:—

	Fusan		Suigen		Chinnampo	
Year	Precipitation (in mm.)	Yield (per cent.)	Precipitation (in mm.)	Yield (per cent.)	Precipitation (in mm.)	Yield (per cent.)
1913	—	—	699	63	—	—
1914	—	—	999	47	—	—
1915	—	—	1,216	56	—	—
1916	2,088	62	1,665	74	665	20
1917	913	37	—	—	630	26
1918	1,658	78	—	—	590	20
1919	1,367	68	—	—	729	16
1920	1,351	45	—	—	537	8

From these data and other considerations, the author has derived the following formula

$$C = .065 A^{1.4} \text{ for "Ordinary yield"}$$

in which  $C$  = monthly yield in mm. and  $A$  = monthly precipitation in mm.

$$C = 0.022 A^{1.55} \text{ for "Dry yield."} \quad \text{N. Yamaguti.}$$

**12. Determination of the Modulus of Elasticity of Concrete** (Japanese). Tadabiko HIBI and Itsuo TAKAHASHI. [J. Civ. Eng. Soc., VII., 6 (1921), 1087-1117

with diag. and table.]—In the investigation concrete blocks of six different proportions varying from 1 cem.+2 sand+3 grav. to 1c.+3s.+6g. by volume were used. Each kind of these blocks was made in two different consistencies, viz., dry and wet, and in four varieties of age, viz., four weeks, three months, six months and one year, making in all 48 sets. Each set consisted of three blocks which were made at the same time and under the same condition.

Denoting by  $\varepsilon_1$  the mean of the three dial-gauge readings which gave the deformations under the stress  $\sigma_1$ , and by  $\varepsilon_2$  that for the succeeding stress  $\sigma_2$ , the modulus of elasticity for compression between these two stresses is expressed by

$$E_c = \frac{\varepsilon_2 - \varepsilon_1}{\sigma_2 - \sigma_1}$$

As the results of the tests, the values of  $E_c$  for the stresses varying from zero to the neighborhood of the ultimate strength of concrete the corresponding stress-strain diagrams were obtained. It was found that the modulus of elasticity is a function of stress, decreasing with the increase of the latter, and that the rate of the decrease gets smaller as the stress becomes lower.

On comparing the moduli of elasticity at one-third of the ultimate strength, (which latter is most likely to occur in concrete constructions) obtained for the various proportions of ingredients, it was found that they were all nearly equal. Likewise the consistency and the age had no influence upon their values. It has thus been found that 270,000 kg/cm<sup>2</sup> is the average modulus of elasticity at one-third of the ultimate strength of concrete. The ultimate strength of concrete was naturally found to vary with the proportion of ingredients, the consistency and the age. The mean ratio of the modulus of elasticity to the ultimate strength was found to be as follows:—

Consistency	Age	4 weeks	3 months	6 months	1 year
Dry		1,773	1,235	969	923
Wet		2,240	1,963	1,168	1,162

These figures will give the modulus of elasticity for any kind of concrete whose ultimate strength is known. Taking 100,000 kg/cm<sup>2</sup> as the average modulus of elasticity of steel used in reinforced concrete, the ratio to that of concrete becomes:

$$n = \frac{E_s}{E_c} = \frac{2,100,000}{270,000} = 7.78$$

Referring to the following empirical formula given by Professors Bach and Schüle for showing the relation between stress and strain in concrete and like materials:

$$\varepsilon = \frac{\sigma^m}{E_0} \text{ where } \varepsilon = \text{unit strain, } \sigma = \text{unit stress, and } m \text{ and } E_0 = \text{coefficients to be determined by experiments, the authors give the values of } m \text{ and } E_0 \text{ for each block found by applying the method of least squares for the stresses running up to the ultimate strength.}$$

The values of  $m$  thus found, vary between 1 and 2.

N. Yamaguti.

### 13. Report of the Committee for Investigation into Light Railway

**Electrification** (Japanese). [J. Imp. Rwy. Assoc., XXII, 1 (1921), 7-14.]—The investigation was made under the following headings each being placed in charge of a sub-committee:

- (1) The past history and present conditions of the Yoro and the Fuji-Minobu Railways.
- (2) Estimated volume of traffic for the ensuing ten years.
- (3) Number of steam and electric trains run, number of vehicles needed and other calculations, as well as the outline of schemes.
- (4) Estimated cost of construction for steam and electric operation.
- (5) Traffic receipts, and working expenses compared for steam and electric operation.
- (6) Conclusion (Relative economy of steam and electric operation).

Summary of investigation regarding Yoro and Fuji-Minobu Railways. The working mileage of the Yoro Railway is 35.8 miles, extending from Ibi to Kuwana, while that of the Fuji-Minobu Railway is 26.9 miles. The amount of traffic for 1928 for both railways was estimated by linear least squares, as based on the actual results for the five years, 1914-18.

The estimated traffic for 1928 thus worked out for the Yoro Railway are: number of passengers carried, 2,924,405; weight of goods transported, 437,906 tons: number of passengers carried for one mile, 19,885,954; and weight of goods transported for one mile, 5,105,192 tons. The figures for the Fuji-Minobu Railway are: number of passengers carried, 1,726,719; weight of goods transported, 488,943 tons: number of passengers carried for one mile, 17,408,940; and the weight of goods transported for one mile, 3,401,385 tons.

According to the foregoing estimates for 1928, the figures which are necessary in drawing up schemes for steam and electric operation were determined, and also the number of trains run, the vehicles needed, etc., were worked out as shown in the appended record of investigation. Upon the bases of the above calculations further investigation was made, and a definite conclusion was arrived at as to the diagrams, velocity, number, unit and composition of trains run, the number of vehicles needed, and schemes for improvements and equipments, etc.

The aggregate cost of construction for the Yoro Railway was 5,600,388 yen for steam, and 6,390,160 yen for electric operation, the latter showing an excess of 759,772 yen or 13.3 per cent. over the former. In a similar way that of Fuji-Minobu Railway was put at 6,484,819 yen for steam, and 7,094,163 yen for electric operation, the latter being greater by 609,944 yen or 9.3 per cent. The traffic receipts were worked out from the estimated figures of traffic for 1928 at the actual rates in force on the railways in the latter half of 1919.

The results obtained as above were, then, compared as to the relative economy of the two systems of operation for both railways. The expenses for improvements and equipments for the Yoro Railway work out at 2,550,500 yen for steam and 3,419,400 yen for electric operation, the latter exceeding the former by 868,900 yen, or being 1.34 times as much as the former. In the case of the Fuji-Minobu Railway the corresponding expenses amount to 2,774,900 yen for steam and 3,575,500 yen for electric operation, the latter being 798,600 yen more than, or 1.29 times as much as, the former. The total working expenses of the Yoro Railway come to 435,976 yen for steam and 348,720 yen for electric operation, the latter being 87,256 yen less than, or 80 % of, the former. In this comparison the price of coal consumed was put at 19.69 yen per ton, i.e. the actual average for 1918 in the railway, while the cost of electric power was put at 2 sen per 1 kw. hr. The percentage of profit to cost of construction amounts to 8.9 for steam and 10.1 for electric operation. The working expenses of the Fuji Minobu Railway total 560,447 yen for steam and 400,772 yen for electric operation the latter being 159,675 yen less than, or 70.1 per

cent. of, the former. The price of coal was put at 24.12 yen per ton, i. e. the actual average for 1918 in the Fuji-Minobu Railway, while the cost of electric power was put at 2.5 sen per 1 kw. hr. The percentage of profit to cost of construction works out at 12.3 for steam and 14.6 for electric operation.

Judging from the above data the Committee consider it advisable for both railways to adopt electric operation when the cost of power is not more than 2.5 sen per 1 kw. hr., unless the price of coal does not fall below 12 yen per ton for the Yoro Railway, and 7 yen per ton for the Fuji-Minobu Railway. Besides the economic advantage, other beneficial effects brought about by electrification are discussed.

From the results of the investigation thus obtained as regards the Yoro and Fuji-Minobu Railways, the Committee has arrived at a conclusion that on the whole it is desirable to electrify the light railways of Japap, not only because the adoption of the electric motive power will prove economical except when the coal price falls extraordinarily low, but it will also facilitate various other improvements.

N Yamaguti.

**14. *Formosan Termites and Methods of Preventing their Damage*** (Japanese). Masamitsu OSHIMA. [J. Imp. Rwy. Assoc., XXII, 4 (1921), 201-214.]—In Formosa and in Japan there are fourteen species of termites, four of which, namely *Coptotermes Formosanus*, *Leucotermes Speratus*, *Leucotermes Flaviceps*, and *Odontotermes Formosanus*, are known as pests of wooden structures. *Coptotermes Formosanus*, which is found in Formosa, Rin Kin Islands and in the southern parts of Japan proper, is especially formidable to buildings. The author has been investigating the habits of *Coptotermes Formosanus* and approached to the problem of the method for prevention with the following ideas as a working basis:

1. Some changes are necessary with regard to the construction of buildings in order to prevent damage by termites.
2. The value of termite-proof building construction is not absolute, unless all sorts of non-resistant timbers are eliminated from the building materials.
3. If shall it be proved that the elimination of non-resistant timbers is practically impossible, it becomes necessary to treat them chemically or physically in order to confer a special resistant property.
4. It is necessary to prove whether there are naturally resistant timbers in the tropics or not.
5. If there are naturally resistant timbers, an investigation with the object of discovering the cause of resistance becomes important.
6. If the causes are definitely known, methods of artificially treating non-resistant timber may be proposed.

The result of a careful study of the habits of *Coptotermes Formosanus* as well as the preventative measures against its damages are given in this paper. It contains:

Description of Formosan termites injurious to wooden structures.

Certain habits of *Coptotermes Shiraki*.

Principal food of *Coptotermes Formosanus Shiraki*.

Termite-proof building construction.

Defects of the termite-proof building construction.

Test of the relative resistance of native and exotic woods.

Relationship between the resistance and the physical properties of timber.

Relationship between the resistance and the chemical properties of timber.



The volatile constituents of cypress-pine.

The volatile constituents of Foochow-cedar and Randai-cedar.

Studies on camphor green oil.

The relative effectiveness of preventatives.

The conclusions reached at are as follows:—

1. *Coptotermes Formosanus* attacks lime mortar.
2. The principal food of *Coptotermes Formosanus* is cellulose.
3. Teak and cypress-pine are absolutely immune from the attack of Formosan termites.
4. The resistance of timber is not due to inorganic compounds contained in it.
5. The resistance of timber is due to organic compounds that can be extracted by benzene or alcohol.
6. Cypress-pine contains "guajacol," a sesquiterpene alcohol.
7. Foochow-cedar and Randai-cedar contain "cedrol," a sesquiterpene alcohol.
8. Camphor green oil contains 25 per cent. of sesquiterpene alcohol.
9. Camphor green oil is entirely satisfactory as a preventative for buildings.
10. The anthracene oil fractionated from coal tar is effective in preventing the damage.
11. The termite-proof concrete layer is entirely satisfactory in preventing the entrance of termites from the ground.

Author.

**15. Railways in Chosen (Korea)** (Japanese). Naoji KADO. [*J. Imp. Rwy. Assoc.*, XXII, 6 (1921), 365-386.]—Chosen possesses a railway system which reached 1,395 miles in 1921 comprising 1,165 miles of the state lines and 230 miles of the private ones. The extension of railway system in Chosen is so slow that at the present rate of progress it is estimated that its total milage will not be more than 3,418 in the next 10 years. This want of activity in railway construction in the country becomes more manifest when its milage is compared with that of Japan proper as shown in the following table:

	Area (sq. ri)	State Rys. (m)	Private Rys. (m)	Milage per 100 sq. ri. (m)
Japan proper	24,704	6,050	2,800	25.70
Chosen	14,123	1,165	230	9.87

**State Railways:**—The pioneer railway in Chosen was that between Keijo and Jinsen built by the Keijin Railway Co. in 1900, and was followed by the Keifu line, built in 1901-05. The Keigi line was constructed by the Japanese Military Railway Administration in 1905, and the Masan line likewise in 1907; both of these lines were opened to traffic in April, 1908. The Keifu and Keijin lines were nationalized in 1906. Since 1917 all the state lines railways in Chosen have been leased to the South Manchurian Railway Co., the Government retaining only the power to plan the new lines. All the lines are of the standard gauge of 4 ft. 8½ in. The capital, so far invested, amounts to about 200,600,000 yen, involving cost for all sorts of equipments, warehouses, railway workshops and hotels. The traffic on the state lines has shown a steady increase; the revenue per mile per day which was 17.0 yen in 1910 increased to 55.0 yen in 1920.

**Private Railways:**—These include all kinds of light railways and tramways operated

either by a corporation or by an individual. The Government has been aiding the extension of private lines in every way: the subsidy which was 6 % in 1914 has since been increased to 8 %. The total length of all private railways in operation in 1920 was 221.8 miles, and those projected and in course of construction 1,484 miles; the capital invested amounting to 126,400,500 yen. Under the present circumstances the extension work is accompanied with difficulties, which close investigations have shown to be mainly the following:—scarcity of passengers and goods traffic; travel of most goods in one direction; influence of market condition on traffic, due to lack in variety of goods; coming out of most goods in a certain season; increasing cost of construction; unfavorable reception of the railway shares by the public; difficulty in securing necessary labor and able staff for construction as well as operation; lack of thorough study of the economy of the schemes; in sufficient supply of motive power; greater expense for equipments. These difficulties are not insurmountable but are great enough to be serious obstacles to the enterprise. N. Yamaguti.

**16. On the Effects of varying the Proportion of Sand and Gravel on the Strength of Concrete** (Japanese). Shukichi NAGAYA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 6 (1921), 1262-1266.]—It has been generally acknowledged that the strength of concrete changes in inverse proportion to the quantity of gravel used. But as a result of actual tests recently made, it was found that the strength of concrete is not as much affected by a variation in the amount of gravel, as by that of sand, the latter being a far more important factor in this respect. The following table shows the digest of the results of the tests.

Compressive Strength of Concrete after 6 months  
(lb. per sq. in.)

Prop. of Cement and Sand		Amount of Gravel					
C	S	0	1	3	5	7	10
1	1	5,573	5,196	4,710	3,526	1,915	
1	2	3,343	2,889	3,109	3,218	2,120	1,287
1	3	3,229	1,790	1,994	2,143	1,853	1,272
1	4	1,366	1,413	1,758	1,648	1,272	973
1	5	973	1,068	1,036	857	973	769

**17. Effects of Aeration on the Strength of Portland Cement** (Japanese). Shukichi NAGAYA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 6 (1921), 1267-1269.]—A series tests of extending over a year was carried out in 1917-18 to find the effects which the length of time a cement is aerated has on its strength, when used in concrete.

As a result, it has been found that though the decrease of tensile strength is very light, compressive strength falls with age to an extent of over 30 % as shown in the following table:—

## Compressive Strength of Concrete.

(lb. per sq. in.)

Proportion by Volume	Aerated Cement.	Age 2 weeks	3 months	6 months	9 months
1 : 2 : 4	A	3,014	2,492	1,743	1,663
	B	3,611	2,983	2,292	2,198
1 : 3 : 6	A	2,041	1,249	1,125	1,002
	B	2,292	1,554	1,497	1,162
1 : 4 : 8	A	1,146	941	822	—
	B	1,529	1,177	1,146	911

A: Cement aerated for 1 month immediately after fabrication.

B:     "     "     6     "     "     "     "     "     "     "     N. Yamaguti.

18. *Results of Tests on Failed and Worn Rails* (Japanese). Koshiro TSUKA-MOTO. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 1 (1921), separate booklet.]—Rails removed, owing either to failure or excessive wear, from the tracks of main lines of the Government Railways during the year 1919, the former numbering 220 in total and the latter 60, were made objects for investigation. The results of chemical analysis, Brinell's ball test, tensile test, impact test and repeated impact test have been recorded with maker's name, year of production, place laid, road conditions, locomotives used, time of failure, life in service, position, nature and cause of failure for each rail. The records show characteristic differences in the products of different makers, in their properties, and especially in the mode of segregation, but no marked relation has been noticed between the nature of failures and the properties of material or size of section. Most of the failures were evidently caused by local defects existing in rails, external or internal, and it is worth drawing the attention of the road men to the fact that 30 % of the broken rails had their origin in the pickspots found at the edges of the rail base.

N. Yamaguti.

19. *On the Nature of Drifting Sands as Affecting Harbour Construction on Sandy Coasts*. Isami HIROI. [J. Coll. Eng. Tokyo Imp. Univ., XI., 3 (1921), 1-82, with fig. and pl.]—Drifting motion of sands or shingles is mainly due to wave actions. Currents aid such motion by transporting the materials while the latter are in state of suspension caused by the lifting power of waves; but they are rarely strong enough to set sands or shingles at rest in motion. Waves advancing at right angles to the shore-line and breaking at the foot of the slope cause changes in the foreshore, differing according to their size. Such waves, when of moderate height, generally cause accretion, while larger waves produce erosion. The slope of a foreshore depends on the exposure of the locality, the depth of water, the frequency and velocity of winds, and the kinds of materials forming the beach. The slope might remain unchanged while the overlying sand may undergo constant renewal. With waves running obliquely to the shore line, the materials on the slope move in well-known zigzag lines, causing a longshore drift. Unbroken waves also cause drifting motion of the bottom materials in the direction of the waves, owing to the preponderance of the forward motion over the backward one. Drifting sands rapidly diminish in amount when the depth exceeds about 30 ft. Wave action reaches to a far

greater depth, but, decidedly, progressive motion results from long-continued repetitive actions, which can only take place with commonly occurring waves.

For a headland to be effective as a drift barrier, the requirements are sufficient extent of projection, absence of excessive obliquity to the shore-line, and sufficient depth of water around it. For an inlet to be similarly effective, sufficient area and depth are considered necessary. Mere absence of sand or shingle along a headland, when seen in a calm weather, is not an unfailing sign of non-existence of drift passing around it, since toward the end of a storm, a wave action less violent than the one that caused the drift might have swept the rocky bottom clear of all the movable materials. Retrogressive drift sometimes occurs in the lee of a structure, when the latter prevents the wave action which previously swept the ground.

For arresting drifting sands, groins are considered most useful; as an instance of a successful work on a large scale, that of the Hakodate Harbour is described. Of the various layout of harbours on sandy coasts, viz: Jetties, single, and converging, and breakwaters, detached and enclosing, are explained with illustrations. Great importance is laid on enclosed harbours, which are discussed with numerous examples, from which the probable amount of yearly dredging necessary for the maintenance of depth in a prospective harbour of the kind is estimated. Further, the important points to be observed in locating the entrance to an enclosed harbour are explained.

Author.

**20. *Annual Report on the River and Harbor Works for 1919*** (Japanese). Bureau of Public Works, Ministry of Home Affairs. [1 Vol. (1921) Tokyo, iv+262, with maps.]—The report briefly describes the various works carried out by the Bureau of Public Works during the year ending March 31, 1919. Under the river works come those executed for the improvement of larger rivers, such as the Tone, the Shinano, the Mogami and more than a dozen others, and also, of smaller rivers, of the torrential class, namely the Daiya, the Yoshino, the Katsura and etc. Among the harbour works are those of Shiogama and Niigata, and the improvement of the Shimonoseki Strait.

N. Yamaguti.

**21. *History of Railways in Japan*** (Japanese). Ministry of Railways. [New Ed. 3 Vol. 1 (1920) Tokyo, 3+21+24+973, with maps and phot.; 2 (1920) Tokyo, 32+871, with maps and phot.; 3 (1921) Tokyo, 26+785+53+181, with maps and phot.]—This voluminous work gives a fairly detailed account of the development of railway system in Japan in the last fifty years. The first railway constructed in this country was between Tokyo and Yokohama in 1871, followed by the Tokaido Line in 1888; both of these lines were built by the government. Meanwhile, companies were organized and set to work on the Tokyo-Aomori Line and the Kobe-Shimonoseki Line, completing the former in 1890 and the latter in 1900. These have formed the trunk lines of the country; the private ones have since been nationalized, together with those built later. Japan has now a railway system of 8,000 miles in the main Island only.

Beside the technical and economical side of the railway work of which the book mainly treats it contains accounts of events, social as well as political, such as are reminiscent of the earlier days of the enterprise, and they are interesting as much to the profession as to the general readers.

N. Yamaguti.

**22. *River Engineering*** (Japanese). Hachiro KIMISHIMA. [New Ed. Vol.



3 (1921) Tokyo, 6+10+353+76+3, with fig., maps and tables.]—The book is a treatise on River and Harbour Engineering. The first two volumes are devoted to meteorology and hydrology in general. The present publication forms the third volume of the work, and treats of River Engineering in its full scope. Under high-water works, embankments and detention-reservoirs are discussed; and under low-water works, spur dikes and parallel work. As illustrations of these, several important river works in Japan and other countries are described. A chapter is devoted to estuary work, and another to improvement of navigable rivers. In the last chapter the regulation of mountain streams and the fixation of the slopes are explained.

N. Yamaguti.

23. *Electrification of Steam Railways* (Japanese). Shigenari YOSHIHARA. [J. Eng. Soc., XL, 445 (1921), 2-13, with fig. and tables.]
24. *Initial Stress in Reinforced Concrete* (Japanese). Tokikazu SAKATA. [J. Eng. Soc., XL, 447 (1921), 120-130, with fig.]
25. *On the Design of the Onogawa Bascule Bridge* (Japanese). Takenosuke MIYAMOTO. [J. Civ. Eng. Soc., VII, 1 (1921), 93-108, with fig. and pl.]
26. *Water Supply for Camps and Cantonments* (Japanese). Chikahiko KOIZUMI. [J. Civ. Eng. Soc., VII, 1 (1921), 20-24, with pl. and tables.]
27. *Recent Development of Sewage Disposal* (Japanese). Isamu KUSAMA. [J. Civ. Eng. Soc., VII, 2 (1921), 227-248, with fig. and pl.]
28. *On Rock Blasting* (Japanese). Shinroku ANDO. [J. Civ. Eng. Soc., VII, 2 (1921), 249-304, with fig., pl. and tables.]
29. *On Hydro-Electric Works in Europe and America* (Japanese). Chuzo MORI. [J. Civ. Eng. Soc., VII, 2 (1921), 183-225, with maps, phot. and pl.]
30. *On the Design of the Shield designed for Use in the Oriutari Tunnel* (Japanese). Yutaka TANAKA. [J. Civ. Eng. Soc., VII, 3 (1921), 429-452, with fig. and pl.]
31. *On the Rapid Transit Railway Works in New York* (Japanese). Tsuneo ITO. [J. Civ. Eng. Soc., VII, 3 (1921), 377-398, with fig. and maps.]
32. *Investigation into the Causes of Damages to the South Breakwater of the Rumoi Harbour* (Japanese). Chiaki HAYASHI. [J. Civ. Eng. Soc., VII, 3 (1921), 473-500, with fig. and pl.]
33. *Erection of Girders with a Derrick Car* (Japanese). Koichi OKOCHI. [J. Civ. Eng. Soc., VII, 5 (1921), 833-867, with fig., phot. and pl.]
34. *On Town Planning in Europe and America* (Japanese). Toshiro KASAHARA. [J. Civ. Eng. Soc., VII, 6 (1921), 1053-1068, with maps.]
35. *On the Design of the Onagigawa Lock* (Japanese). Takenosuke MIYAMOTO. [J. Civ. Eng. Soc., VII, 6 (1921), 1125-1180, with fig., phot. and pl.]

36. *Modes of Transportation in China* (Japanese). Mitsuo NAWA. [J. Civ. Eng. Soc., VII, 6 (1921), 1069-1086, with maps, phot. and pl.]
37. *Derrick Car as an Appliance for Bridge Erection* (Japanese). Takesada KURODA. [J. Civ. Eng. Soc., VII, 4 (1921), 639-650, with phot. and pl.]
38. *Narrow Gauge Railways in China* (Japanese). Kiyoshi KANAI. [J. Imp. Rwy. Assoc., XXII, 1 (1921), 15-19.]
39. *On the Revision of Freight Classification and Tariffs in Japanese Government Railways* (Japanese). Syotaro KAKEHI. [J. Imp. Rwy. Assoc., XXII, 1 (1921), 21-32.]
40. *The Question of Railway Gauge in Japan* (Japanese). Yasujiro SHIMA. [J. Imp. Rwy. Assoc., XXII, 2 (1921), 59-78.]
41. *On Railway Management in America* (Japanese). Kumataro KISHIMOTO. [J. Imp. Rwy. Assoc., XXII, 2 (1921), 79-86.]
42. *Railways in Formosa* (Japanese). Shikanosuke NIIMOTO. [J. Imp. Rwy. Assoc., XXII, 4 (1921), 229-236.]
43. *Modern Tendencies in Structural Engineering* (Japanese). Masataka YAMADA. [J. Imp. Rwy. Assoc., XXII, 5 (1921), 277-284.]
44. *Adoption of Metric System in Railway Works* (Japanese). Tohihisa SATO. [J. Imp. Rwy. Assoc., XII, 5 (1921), 285-326, with diag. and tables.]
45. *On the Electrification of Railways in Switzerland* (Japanese). Kiichi ASAKURA. [Bull. Imp. Gov. Rwy. Research Bureau, IX, 3 (1921), 388-416.]
46. *On the Electrification of Railways in France* (Japanese). Kiichi ASAKURA. [Bull. Imp. Gov. Rwy. Research Bureau, IX, 3 (1921), 373-388.]
47. *On Three Position Automatic Signals* (Japanese). Kozo FURUKAWA. [Bull. Imp. Gov. Rwy. Research Bureau, IX, 5 (1921), 832-869, with pl.]
48. *An Automatic Lock and Block Apparatus* (Japanese). Kiichiro KOYAMA. [Bull. Imp. Gov. Rwy. Research Bureau, IX, 5 (1921), 809-816, with fig.]
49. *On Harbor Works in France* (Japanese). Kiichi ASAKURA. [Bull. Imp. Gov. Rwy. Research Bureau, IX, 6 (1921), 1315-1325.]
50. *On the Durability of Sleepers as affected by the Roadbeds* (Japanese). Masanori NUMATA and Kanehiro SUGAYAMA. [Bull. Imp. Gov. Rwy. Research Bureau, X, 6 (1921), 1245-1261, with pl. and phot.]
51. *Scientific Method of the Maintenance of Way* (Japanese). Masataka YAMADA. [Bull. Imp. Gov. Rwy. Research Bureau, IX, 7 (1921), 1-12.]

52. *Station Signals in an Automatic Block Section* (Japanese). Bunziro SAWA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 7 (1921), 13-18, with fig.]
  53. *Diagram of Bending Moments caused by Locomotives used on Japanese Government Railways* (Japanese). [Bull. Imp. Gov. Rwy. Research Bureau, IX., 4 (1921), 619-620, with diag.]
  54. *Wear of the Third Rail* (Japanese). [Bull. Imp. Gov. Rwy. Research Bureau, IX., 8 (1921), 213-232, with fig. and tables.]
  55. *On Railway Management in Prussia* (Japanese). Masasa NAKAGAWA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 9 (1921), 351-372.]
  56. *Measurement of Tractive Resistance of Trains* (Japanese). Kenziro KUWABARA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 10 (1921), 515-529, with fig. and tables.]
  57. *Report on the Competitive Designs for the Yellow River Bridge* (Japanese). Takuichi OMURA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 11 (1921), 749-780, with maps, pl. and tables.]
  58. *On Stresses Produced in Foundations* (Japanese). Takenosuke MIYAMOTO. [Kogaku, VIII., 3 (1921), 10-16.]
  59. *On Unsteady Flow* (Japanese). Masao HIRANO. [Kogaku, VIII., 3 (1921), 133-140, with tables.]
  60. *Forestation as a Means of Flood Prevention* (Japanese). Ichi NAKAMURA. [Kogaku, VIII., 3 (1921), 191-198, with fig.]
  61. *On City Planning* (Japanese). Tokikazu SAKATA. [Kogaku, VIII., 3 (1921), 153-163.]
  62. *On Regulations for Reinforced Concrete Construction* (Japanese). Tokikazu SAKATA. [Kogaku, VIII., 5 (1921), 275-281.]
  63. *On Pavement and Paving Materials* (Japanese). Toru YAMAMOTO. [Kogaku, VIII., 11 (1921), 575-580.]
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## MECHANICAL ENGINEERING (I—22).

**1. Thermal Effect on Young's Modulus of Piston Packing Ring of Internal Combustion Engine** (Japanese). Gompachi ASAKAWA, Soich ISHIZUKA and Uichi HASHIMOTO. [J. Soc. Mech. Eng. Tokyo, XXIV., 63 (1921), 7-16, with fig.]-The authors describe the experiments on several piston packing rings taken from Daimler, Buick, Renault and Ford engines for the purpose of determining the variation of Young's modulus of the materials under the influence of high temperature, and the consequent change of packing pressure of the rings against the cylinder wall. It is concluded that in the case of the cast iron ring the rate of decreasing of the modulus of elasticity is about 3% per 100° C. for temperatures below 600° C., and that at 700° C. the modulus becomes 70-75% and at 800° C. about 30% of that at the ordinary temperature. S. T.

**2. Strut of Uniform Strength for Combined Axial and Lateral Forces** (Japanese). Kazu SHOGENJI. [J. Soc. Mech. Eng. Tokyo, XXIV., 63 (1921), 17-27 (back), with fig.]-A mathematical investigation on a long strut of uniform strength, hinged at the ends and loaded axially and laterally is described. The lateral load is assumed to be distributed uniformly along the length and to be balanced by moments acting at the ends. When the depth  $h$  (supposed to be parallel to the plane of bending) of the section of a strut is constant and breadth  $b$  variable, the required form of section is given by  $b/b_0 = 1 - (x/l)^2$ ; when the breadth  $b$  is constant and the depth  $h$  variable, it is given by  $(x/l)^2 = 1 - (h/h_0)^2$ ; and when the sections are similar rectangles, it is given by  $(x/l)^2 = 1 - (h/h_0)^3$ , where  $l$  is the length of the strut;  $x$ , the distance of a section measured from the middle of the strut; and  $h_0$  and  $b_0$ , the depth and the breadth at the middle section, respectively. It is concluded that the form of section of the strut of uniform strength does not depend on the lateral load which is distributed uniformly along the length. S. T.

**3. Long Strut of Minimum Volume** (Japanese). Keiichi AICHI. [J. Soc. Mech. Eng. Tokyo, XXIV., 63 (1921), 17-30, with fig.]-The paper gives mathematical investigations on the form of transverse section of a long strut of minimum volume of material for the given length  $l$  and the given axial load  $H$ . Formulae are worked out for the case of a vertical strut fixed at the base and free at the top end. Let  $E$  be Young's modulus;  $I_0$ , the moment of inertia of the middle section of the strut which is considered constant.  $I = I_0 \xi^n$  that at any section; a function of the distance  $x$  measured along the length of the strut, and  $C$  and  $n$  the constants depending on the shape of the section; then for a rectangular section of constant depth and variable breadth in which the deflection is proportional to the breadth  $\frac{Hl^2}{EI_0} = C = 8$ ,  $n = 1$  and  $\frac{l}{2} \left\{ 1 - \sqrt{1 - \xi} \right\} = x$ ; for a rectangular section of constant breadth and variable depth in which deflection is proportional to the square of depth  $C = \left(\frac{8}{9}\right)^2$ ,  $n = 3$  and  $\frac{l}{2} \left\{ 2 - (\xi + 2)\sqrt{1 - \xi} \right\} = x$ ; for circular section of variable diameter, elliptic section and rectangular section of similar shape  $C = \frac{3}{4}\pi^2$ ,  $n = 4$  and  $\frac{l}{\pi} \left\{ \arcsin \xi - \xi \sqrt{1 - \xi^2} \right\} = x$ . S. T.



**4. On the Elastic Curve of Long Column as affected by Lateral Forces and by its own Weight** (Japanese). Tatsuzo FUKUHARA. [J. Soc. Mech. Eng. Tokyo, XXIV., 63 (1921), 31-39, with fig.]—An equation of the elastic curve is obtained for the case in which the long column is fixed vertically at the base and free at the top, and is expressed in ascending powers of the distance  $x$  measured along its length from the free end of the column. S. T.

**5. Automatic Typewriting Revolution Counter** (Japanese). Seinen YOKOTA and Kiyosi TOMIZUKA. [J. Soc. Mech. Eng. Tokyo, XXIV., 63 (1921), 1-12 (back), with fig.]—The automatic typewriting revolution counter, (or the automatic figure-printing chronometric tachometer) is a device of measuring and recording chronometrically the speed of a rotating shaft, its indication being expressed with figures and printed automatically on a strip of paper by a kind of typewriter in each nine seconds. K. T.

**6. On the Heat Treatment of Gunmetals** (Japanese). Shimpei TONAMI. [J. Soc. Mech. Eng. Tokyo, XXIV., 64 (1921), 1-15, with fig. and pl.]—Effects of heat treatment of two kinds of gunmetal, one of which is of 90 % Cu and 10 % Sn, and the other of 88 % Cu, 10 % Sn and 2 % Zn, are described. The specimens were treated at various temperatures from 300° to 800° C. The changes of strength, elongation elastic limit, hardness, electrical resistance and specific gravity are investigated; microphotographic investigations are also described. S. T.

**7. Strength of Rectangular Flat Plate loaded uniformly and fixed or supported at the Periphery** (Japanese). Ariya INOKUTY. [J. Soc. Mech. Eng. Tokyo, XXIV., 64 (1921), 45-57, with fig.]—In a rectangular plate whose sides are  $2a$  and  $2b$ , a strip BOB of width unity through the centre O of the plate and parallel to one of side  $2b$  is considered. If  $a$  is infinitely increased the stress and strain in the strip will become the same in value as those in a simple beam of width unity fixed or supported at the ends of span  $2b$  and under the action of uniform load  $p$  per unit length of the span. If the beam is merely supported at the ends, the bending moment at the centre of span is  $\frac{1}{2}pb^2$ , and if rigidly fixed in direction, it is  $\frac{1}{6}pb^2$ . Hence a general expression for it is  $\frac{1}{2}(1-n)pb^2$ , in which  $n$  is zero in the first case,  $\frac{2}{3}$  in the second case, and when the ends are partially fixed in direction,  $n$  has a positive value less than  $\frac{2}{3}$ . From the above consideration the equation of the neutral axis of the strip BOB is obtained, thus  $Z_b = -\frac{p}{24EI}(b^2-x^2)\left\{(5-6n)b^2-x^2\right\}$ ; and similarly for that of the strip AOA perpendicular to BOB when  $b$  is infinitely large  $Z_a = -\frac{p}{24EI}(a^2-x^2)\left\{(5-6n)a^2-x^2\right\}$ . For the surface formed by the neutral layer of the plate after bending, the author makes use of the following equation which is similar to the equation assumed by Grashof, but more in general:—

$$Z = Z_a \cdot Z_b \cdot \left\{ (Z_a)_{x=0} + S \sqrt{(Z_a)_{x=0} \cdot (Z_b)_{y=0}} + (Z_b)_{y=0} \right\}$$

in which  $S$  is an arbitrary coefficient. The numerical values of the deflections and stresses

computed by the formulae based on the above principle show a close agreement with the result of experiments made by Montgomerie. S. T.

**8. Test on Fuels of the Automobile Motor** (Japanese). **Genjiro HAMABE**. [J. Soc. Mech. Eng. Tokyo, XXIV., 67 (1921), 13-20.]—Comparison tests were made with Miike benzole, Miike "litols" No. 1 and No. 2, and ordinary petrol as motor fuels. A 4 ton military truck powered with 28 HP motor of vertical four, 116 mm.  $\times$  140 mm., was employed for the experiment. The motor was made to run always at 1,000 r.p.m., developing about 20 HP, for 2 hours for each fuel. The results are as follows:—

	Petrol	Benzole	Litol No. 1	Litol No. 2	Litol No. 2'
Brake Horse Power	20.3	20.4	20.4	19.4	19.9
Fuel consumption (l./HP. h.)	0.405	0.379	0.374	0.414	0.489
" " (Kg./HP. h.)	0.295	0.331	0.324	0.360	0.425
Brake thermal efficiency (%)	19.35	18.32	20.04	17.93	15.19
Ratio of quantity of air required for complete combustion to that actually supplied	1.093	1.194	1.232	1.185	0.995
Temperature of exhaust gas ( $^{\circ}$ C.)	594.1	526.1	580.4	579.3	545.2
Exhaust gas analysis (volume %)	{ CO <sub>2</sub>	12.07	12.89	12.91	12.76
	{ O <sub>2</sub>	2.16	3.68	4.19	3.72
	{ CO	0.50	0.19	0.14	0.57
	{ N <sub>2</sub>	85.27	83.24	82.76	83.20
Specific gravity	0.729	0.874	0.867	0.870	
Heat value (kg-cal./kg.)	11,245	10,585	9,884	9,941	
Chemical analysis (weight %)	{ C	84.89	90.54	89.51	90.86
	{ H	14.72	7.92	8.35	7.72
	{ S	0.06	0.51	0.14	0.15
	{ N+O	0.33	1.03	2.00	1.27

S. T.

**9. On the Cold Working of Metals** (Japanese). **Akimasa ONO**. [J. Soc. Mech. Eng. Tokyo, XXIV., 68 (1921), 1-13, with fig. and pl.]—The author describes the results of his experiment made with annealed copper wire, cold drawn copper wire and silicon copper wire, each is of about 2 mm. in diameter, with the object of investigating the effects of cold working on the strength of metals. The chief results of various tests are as follows:—

		Annealed copper wire	Cold drawn copper wire	Silicon copper wire
Tension test.	Gauge length in mm.	20	20	20
	Ultimate strength (mean) in kg/cm <sup>2</sup>	2,520	4,560	6,530
	Elongation (mean) in %	55		
	Contraction of sectional area (mean) in %	73.5	48.8	37.9
Impact test. (longitudinal)	Gauge length in mm.	150	150	150
	Rupture work per unit volume (mean) in mkg/cm <sup>3</sup>	11.2	0.85	1.74
Repeated stress test.	Mean no. of rep. under	100 kg.	511,080	742,971
		80 "	959,937	837,267
		60 "	902,044	2,959,034
		50 "	3,713,873	2,494,566

It is concluded that the cold working of metals should not be considered as means to make the material stronger to resist various kinds of stress, but that to reduce the effect of elastic afterworking which proceeds with time.

**10. Strength of Flat Elliptical Plate loaded uniformly and supported at the Perimeter.** Tsuruzo MATSUMURA. [J. Soc. Mech. Eng. Tokyo, XXIV., 68 (1921), 31-40, with figs.]—A new expression  $Z = Z_0 \left( 1 - \frac{A x^2}{a^2} - \frac{B y^2}{b^2} \right) \left( 1 - \frac{x^2}{a^2} - \frac{y^2}{b^2} \right)$ ,

where  $Z$  is the deflection normal to the plate;  $Z_0$ , that at the center;  $a$  and  $b$ , semi-axes,  $A = \frac{mb^2 + a^2}{5mb^2 + a^2}$ ,  $B = \frac{ma^2 + b^2}{5ma^2 + b^2}$  and  $\frac{1}{m}$  the Poisson's ratio, is proposed as an approximate equation for the elastic mid layer of an elliptical plate, loaded uniformly and supported at the periphery. The stress components are obtained as follows:

$$\sigma_x = \frac{4GZ_0}{m-1} \left\{ \frac{m(1+A)}{a^2} + \frac{1+B}{b^2} - \left( \frac{6mA}{a^2} + \frac{A+B}{b^2} \right) \frac{x^2}{a^2} - \left( \frac{6B}{b^2} + \frac{m(A+B)}{a^2} \right) \frac{y^2}{b^2} \right\} v,$$

$$\sigma_y = \frac{4GZ_0}{m-1} \left\{ \frac{m(1+B)}{b^2} + \frac{1+A}{a^2} - \left( \frac{6mB}{b^2} + \frac{A+B}{a^2} \right) \frac{y^2}{b^2} - \left( \frac{6A}{a^2} + \frac{m(A+B)}{b^2} \right) \frac{x^2}{a^2} \right\} v,$$

$$\tau_{xy} = -\frac{4m^2E}{m^2-1} Z_0 y \left( \frac{A+B}{a^2b^2} + \frac{6B}{b^4} \right) \left( \frac{h^2}{8} - \frac{\tau^2}{2} \right),$$

$$\tau_{yx} = -\frac{4m^2E}{m^2-1} Z_0 x \left( \frac{A+B}{a^2b^2} + \frac{6A}{a^4} \right) \left( \frac{h^2}{8} - \frac{\tau^2}{2} \right),$$

$$\tau_{xz} = -8 GZ_0 v (A+B) \frac{xy}{a^2b^2},$$

where  $G$  and  $E$  are rigidity and Young's modulus, respectively;  $v$  the distance measured normally from the mid layer; and  $h$ , the thickness of the plate. It is shown that the greatest stress  $\sigma_{y0}$  which occurs at the center of the plate, calculated from the above equation is greater than that which really exists; hence the error is on the safe side. The results of stress calculation show a close agreement with those obtained from Bach's approximate formula.

S. T.

**11. On the Leakage of Water through the Clearance Rings in a Centrifugal Pump.** Otagoro MIYAGI. [J. Soc. Mech. Eng. Tokyo, XXIV., 68 (1921), 60-30, with fig.]—The water leakage through the clearance rings at the outer and inner edges of the impeller is investigated mathematically. The quantity of leakage  $q$ , the volumetric efficiency  $\mu$ , the loss of head due to the leakage  $h$  and the efficiency of clearance rings  $\epsilon$  of a pump with an impeller 75 cm. in diameter running 380 r. p. m. are calculated for various quantities of discharge. When the discharge quantity  $Q$  is small  $\epsilon$  and  $\mu$  are also small but with increasing  $Q$  they increase rapidly; at  $Q=250$  l/s they reach a constant value of about 99%; while  $h$  decreases rapidly with increasing  $Q$  taking a minimum value of 6.5 cm. at about  $Q=420$  l/s.

S. T.

**12. Air Conditioning in Textile Mill** (Japanese). Masanosuke YANAGI-MACHI. [J. Soc. Mech. Eng. Tokyo, XXIV., 69 (1921), 11-23, with fig.]—A short survey of the various methods of air conditioning in a textile mill with special reference to Carrier's method.

S. T.

**13. On the Dressing of Cotton Tissue.** (Japanese). Hirotaro NISHIDA. [J. Soc. Mech. Eng., Tokyo, XXIV., 69, (1921), 25-29, with fig.]—A short description on the dressing of cotton tissue.

S. T.

**14. Elastic Equilibrium of a Circular Cylinder strained by the Axial Variation of Temperature** Toyotaro SUHARA. [J. Soc. Mech. Eng. Tokyo, XXIV., 70 (1921), 81-92, with figs.]—The displacement equations of equilibrium are solved for a long hollow circular cylinder in which the axial distribution of temperature is given by a relation of the form  $t=T_0 e^{-\alpha x}$ , in which  $t$  is the temperature;  $x$ , the distance along the length of the cylinder; and  $T_0$  and  $\alpha$ , the constants. This is a case which occurs often in engineering practice as in pistons, piston rods and cylinders of the internal combustion engines. The following expressions for stresses are obtained under the assumption that the cylinder is free from traction and shear over its curved surfaces:—

$$\begin{aligned}\sigma_r = & -2G e^{-\alpha x} \left\{ \frac{(3m-2)A_1 + (m-2)A_2}{4(m-1)} J_0(\alpha r) + \frac{(3m-2)A_1' + (m-2)A_2'}{4(m-1)} Y_0(\alpha r) \right. \\ & \left. - \left( \frac{A_1}{\alpha r} + B'r \right) J_1(\alpha r) - \left( \frac{A_2'}{\alpha r} + B'r \right) Y_1(\alpha r) + \frac{m+1}{m-1} \alpha T_0 \right\}, \\ \sigma_t = & -2G e^{-\alpha x} \left\{ \frac{(m-2)(A_2 - A_1)}{4(m-1)} J_0(\alpha r) + \frac{(m-2)(A_2' - A_1')}{4(m-1)} Y_0(\alpha r) \right. \\ & \left. + \frac{A_1}{\alpha r} J_1(\alpha r) + \frac{A_1'}{\alpha r} Y_1(\alpha r) + \frac{m+1}{m-1} \alpha T_0 \right\}, \\ \sigma_x = & 2G e^{-\alpha x} \left\{ \frac{(2m-1)A_2 - A_1}{2(m-1)} J_0(\alpha r) + \frac{(2m-1)A_2' - A_1'}{2(m-1)} Y_0(\alpha r) \right. \\ & \left. - B'r J_1(\alpha r) - B'r Y_1(\alpha r) \right\},\end{aligned}$$

$$\tau = G e^{-\lambda z} \left\{ (.I_1 + .I_2) f_1(\lambda r) + (.I_1' + .I_2') Y_1(\lambda r) + 2B'r f_0(\lambda r) + 2B'r' Y_0(\lambda r) \right\},$$

in which  $\sigma_r$ ,  $\sigma_t$ ,  $\sigma_z$  and  $\tau$  are the stress components;  $G$ , the rigidity;  $1/m$ , Poisson's ratio;  $\alpha$ , the coefficient of thermal expansion;  $r$ , the radius of cylinder,  $A_1, A_1', \dots, B, B'$ , the constants; and  $f_n(\lambda r)$  and  $Y_n(\lambda r)$ , Bessel functions of first and second kinds.

The radial displacement at the outer surface of cylinder is given by

$$(\rho)_{r=r_2} = \alpha \cdot T_0 e^{-\lambda z} r_2 \left\{ \left( \frac{-2(m+1)}{m\lambda r_2} \right) \begin{bmatrix} f_0(\lambda r_1) & Y_0(\lambda r_1) & M_1 \lambda r_1 & 1 \\ f_0(\lambda r_2) & Y_0(\lambda r_2) & 0 & 1 \\ f_1(\lambda r_1) & Y_1(\lambda r_1) & \lambda r_1 Z_{01} & 0 \\ f_1(\lambda r_2) & Y_1(\lambda r_2) & -1 & 0 \end{bmatrix} \right. \\ \left. \begin{bmatrix} f_0(\lambda r_1) & Y_0(\lambda r_1) & M_1 f_1(\lambda r_1) & M_1 Y_1(\lambda r_1) \\ f_0(\lambda r_2) & Y_0(\lambda r_2) & M_2 f_1(\lambda r_2) & M_2 Y_1(\lambda r_2) \\ f_1(\lambda r_1) & Y_1(\lambda r_1) & \lambda r_1 f_0(\lambda r_1) & \lambda r_1 Y_0(\lambda r_1) \\ f_1(\lambda r_2) & Y_1(\lambda r_2) & \lambda r_2 f_0(\lambda r_2) & \lambda r_2 Y_0(\lambda r_2) \end{bmatrix} \right\},$$

where  $r_1$  and  $r_2$  are the inner and outer radius of the cylinder respectively,

$$M_1 = [2(m-1)/m\lambda r_1] - \lambda r_1, \quad M_2 = [2(m-1)/m\lambda r_2] - \lambda r_2,$$

and

$$Z_{01} = \begin{bmatrix} f_0(\lambda r_1) & Y_0(\lambda r_1) \\ f_1(\lambda r_2) & Y_1(\lambda r_2) \end{bmatrix}, \quad Z_{11} = \begin{bmatrix} f_1(\lambda r_1) & Y_1(\lambda r_1) \\ f_1(\lambda r_2) & Y_1(\lambda r_2) \end{bmatrix}.$$

Numerical examples are given for solid and hollow cylinders, with stress and displacement diagrams for special cases. Author.

**15. On Planing the Lathe Bed and Setting the Lathe** (Japanese). **Hosaku IWAOKA**. [J. Soc. Mech. Eng. Tokyo, XXV., 71 (1921), 1-5, with fig.]-The author describes new methods of planing a lathe bed and of setting a lathe accurately, by using a special "measuring jack" devised by him. S. T.

**16. Experiment on Hack Sawing Machine** (Japanese). **Yaekichi SEKI-GUCHI**. [J. Soc. Mech. Eng. Tokyo, XXV., 71 (1921), 41-70, with fig.]-The author made a series of experiments with a hack sawing machine for the purpose of determining the relation between the cutting rate, consumed power, pressure on the work etc. The results may be summarized as follows: (1) The pressure on the work should be adjusted properly according to the form of saw blade, the type of machine, the size of the work and the method of cooling. (2) In the case of a mild steel rod of 2 inch diameter, the most suitable pressure is 17.1 lbs. per inch of blade when poured with soap water, and is 13.5 lbs. when dry. (3) For mild steel a mean cutting velocity of 100 ft. per min. gives the best results, no matter whether the soap water is used or not. (4) Cutting power can be saved by 40 % in using soap water compared with dry cutting. (5) For cast iron, the suitable pressure is from 13.5 lbs. to 14.9 lbs. per inch of blade and the suitable cutting speed is 64 ft. per min. (6) In the case of tool steel much higher pressure must be applied on. K. K.

**17. Relation between Size and Horse Power of Lathe** (Japanese). **Take-taro MATSUDA**. [J. Soc. Mech. Eng. Tokyo, XXV., 71 (1921), 33-40, with pl.]-A short account on the modern practice of the engine lathe powering in America and Europe is given. The following formula, based solely on practical data, for the relation between the size and horse power of the lathe is proposed by the author:



$$HP = C(H-5),$$

where  $H$  is the height of centres in inches, and  $C=1.5$  for heavy duty lathes, 1.0 for medium duty lathes and 0.5 for light duty lathes. S. T.

**18. A Test for determining the Pressure Drop of a Locomotive Boiler due to Standing** (Japanese). Kenjiro KUWABARA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 1 (1921), 41-63, with fig.]—From March 1914 to January 1915, tests were carried out at the Ōi Laboratory of the Government Railways, to determine the pressure drop of a locomotive boiler when it was left stand still. The loss of heat was found to be about 24% less, when the chimney was closed by a cover, than when it was open. The results are summarized as follows:—

Time elapsed in hours	Pressure in lbs/in <sup>2</sup> .		Pressure drop per hour in lbs/in <sup>2</sup> .	
	Chimney covered	Chimney open	Chimney covered	Chimney open
Initial	86	95	—	—
2	58	60	13	16
4	39	37	8	10
6	28	25	6	6
8	12	25	4	6
10	19	21	5	5

R.

**19. Results of Tests on Class 18900 Locomotive** (Japanese). Kenjiro KUWABARA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 7 (1921), 81-105, with figs and tables.]—The 4-6-2 type superheated steam tender locomotive, class 18900, which was newly designed and built by the Japanese Government Railways, was tested on the Tokaido line between Tokyo and Kobe. From the results of trial run various formulae have been obtained. The following are those for the most usual cut off, 28%:—

$$\begin{aligned} f &= 60-0.55 V, & f_m &= 106-0.95 V, \\ T &= 17300-154 V, & HP &= 46 V-0.41 V^2 \end{aligned}$$

where  $f$  is the ratio of the mean effective pressure to the boiler pressure in %;  $f_m$ , the mean effective pressure in lbs. per sq. inch;  $T$ , the tractive force at tread in lbs.;  $HP$ , the indicated horse power; and  $V$ , the speed of train in miles per hour. R.

**20. Calculation of Heating Value of Coal** (Japanese). Kenjiro KUWABARA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 7 (1921), 107-115.]—At the Ōi Laboratory the heating value of coal is worked out by means of the following formula.

$$P = 80 C + a V - 10 H,$$

where  $P$  is the heating value (calories);  $C$ , the fixed carbon (%);  $V$ , the volatile matter (%);  $H$ , the water (%).

The value of  $a$  is determined by the quality of coal as follows:—

for good swelling and caking coal,	100
for swelling and caking coal,	100
for medium swelling and caking coal,	95

for caking coal,	90
for semi-caking coal,	80
for non-caking coal,	75

Of the non-caking, those which contain larger proportion of ashes are graded as 70.

The results worked out by the above formula have been found to differ by only about 2% from the actual results obtained by the calorimeter. R.

**21. Train Resistance** (Japanese). Kenjiro KUWABARA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 10 (1921), 515-529, with fig. and tables.]—A formula for the train resistance has been obtained from the results recorded in a dynamometer car in the trial run of the locomotive No. 18900; as

$$R = 3 + 0.0032 V^2$$

where  $R$  is the net resistance, that is, the resistance of the train when running on a level, straight track, in lbs. per ton of train load. Corrections for curves, gradients, wind speeds and directions etc. are also considered. R.

**22. Tests on Feed Water Heater** (Japanese). Kenjiro KUWABARA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 11 (1921), 663-668.]—Recently a feed water heater was tested on a locomotive, on which the feed pump was operated from the cross head. On the mountainous districts the train speed is very slow. So the pump is operated without any difficulty.

The heater and the pump were first put on the experimental locomotive at the Ōi Laboratory, and were compared with the ordinary method of feeding water by means of an injector, and it was found that the fuel could be economized by 20 per cent. A trial of the new method as carried out on a line in mountainous districts proved that the saving was 10 to 14 per cent.

The summary of these experiments is given below:—

Place where tested		Tested with	No. of tests	Coal consumed	Coal per hour per tractive HP. (lbs.)	Coal per car mile (kin).	Coal economized by f. w. h. (%)
Ōi Laboratory		Heater	9	1,108	4.33		19
		Injector	6	1,349	5.16		
		Heater	6	1,778	4.71		17
		Injector	11	2,087	5.52		
Central Line	Hachiōji-Enkyo	Heater	12	1,510		3.74	
		Injector	13	1,654		4.12	10
	Kōfu-Enkyo	Heater	24	1,931		5.66	
		Injector	24	2,197		6.44	14
	Kōfu Kamisutwa	Heater	17	2,559		5.38	
		Injector	21	2,788		5.90	10
	"	Heater	20	2,431		5.11	
		Injector	20	2,734		5.75	12

## NAVAL ARCHITECTURE (1-12).

1. *On an Example of Breakage of Propeller Blades* (Japanese). Shintaro SASAKI. [J. Soc. N. A., 27 (1921), 1-43, with fig.]—Tensile tests, repeated impact tests, toughness tests, results of chemical analysis and composition of the alloy, relation between the composition, microscopic analysis and mechanical properties, size of grains and their growth during the use of material, relation between the distribution of blow holes and the size of grains, the causes of the growth of blow holes, the causes of breakage of propeller blades, the relation between the distribution of blow holes and the mechanical properties are investigated, and treated in detail.

M. Kondo.

2. *On an Electrically Welded Ferry Boat* (Japanese). Tetsuo MIMURA. [J. Soc. N. A., 27 (1921), 71-89, with fig. and tables.]—Notes on the experience gained in the construction of an electrically welded ferry boat in the Mitsubishi yard, Nagasaki. The dimensions of the boat 110' pp.  $\times$  32'  $\times$  8' moulded depth. Electric equipment: two motors of 44 and 80 k. w. delivered by the motors at 80-90 volts, further reduced to 20-23 volts at the electrodes. Full weld, light weld, and tack weld, as well as various combinations of these, V or butt weld, half plug and full plug welds, were all employed according to the requirements.

The mode of construction:—In welding frames to the outside plating and keel plates, plug weld was used, alternately half and through, holes being 7D apart in the frame flange and 14D in the plating. Similar procedure was adopted in welding deck plating to beam holes being spaced 7D apart in the plating and 14D in beam flanges, thus avoiding overhead welding entirely. Seams and butts were made only  $1\frac{1}{2}$ " wide, instead of  $2\frac{1}{2}$ " for seams and  $4\frac{1}{2}$ " for butts when riveted. The upper edges were full welded and the lower tack welded. Bulkheads were completely built up on the ground and taken to the boat to be welded. Seams, butts and bounding angles were full welded on the caulking side and tack welded on the other. The outside plating was welded similarly to the deck plating. Seams were full welded outside and tack welded inside, while butts were full welded outside and light welded inside.

In the case of the deck girder, a continuous flanged plate was used, the parts to fit the beam being burnt out by gas, and welded on to the deck plating and beam.

Precautions in working: Precautions are necessary to prevent deformation. In tack welding, care should be taken that the pitch is not too great, 2" to  $2\frac{1}{2}$ " being about for  $\frac{1}{4}$ " and  $\frac{3}{8}$ " plating. Much care is also needed when adding on a new electrode. In welding a stiffener to the bulkhead plating, it is advisable to make the flange of the stiffener slightly convex to minimize the deformation. The waste of electrode in welding is the least in the flat welding, about 90 % being usefully incorporated in the weld, the corresponding figures for the vertical and overhead welds, being 60 %, and 40 %, respectively.

Saving due to the use of the electric welding:—Weight is saved in nearly every case, amounting to 10 % to 15 % or more in certain cases.

M. Kondo.

3. *On a Reinforced Concrete Lighter* (Japanese). Kyoji SUYEHIRO. [J. Soc. N. A., 27 (1921), 91-99, with fig.]—Principal dimensions: 77' o.a.  $\times$  18'  $\times$  7'. The points of originality are:

I. The side members of the hatch are designed to form a part of the longitudinal members of the boat.

II. Iron bars in the side are arranged diagonally, so as to form the web to connect the deck and bottom of the boat. The stress on the bars due to bending and the water pressure is about 13,000 lbs. per sq. in., while the compressive stress on the concrete is about 600 lbs. per sq. in.

General remarks on concrete vessels:—In order to lessen the weight, it may be advisable to use cinder, slag, pumice or similar material for the aggregate. No anxiety need be felt with regard to hair cracks, as certain tests made show that even with pronounced cracks the insulation remains unimpaired, indicating the presence of a thin film of concrete round the iron bar which completely protects it. M. Kondo.

**4. The Effect of the Shape of the After Body of a Vessel on the Propeller Efficiency** (Japanese). Shintaro MOTORA. [J. Soc. N. A., 27 (1921), 195–206, with fig. and tables.]—Models used in experiments:—Three models of the following proportions were used:—length 400', breadth 50', draught of water 26.147' full, 19.215' half load, displacement 11,550 tons full, 8,200 tons half load; model I has V shaped after body, model III U-shaped ditto and model II intermediate; different inclinations of bossing to the horizontal; single and twin screws; propeller for single screw 17' dia. by 18' pitch, for twin screws 15'–6'' dia., 17' pitch, both outward turning.

Results of experiments:—E. H. P. for bare hull.—I slightly superior to II, III decidedly inferior; at 12 knots full, E. H. P. of III 20 % greater than that of I, at 15 knots half load 23 %.

Effect of the inclination of bossing:—II with the least inclination gives the best results. In II, E. H. P. is almost the same with or without bossing, while in III, it is actually less with bossing added, due, no doubt, to the change in the stream line motion. The reason that, in I E. H. P. is much increased by adding bossing, is due, probably, to the excessive size of the bossing required. Displacement of bossing I, 70 tons; II, 40 tons; III, 24 tons on the average.

Effect of bossing on the propeller efficiency:—II with the least inclination of bossing shows the best results. Hull efficiency is always the best in the case of the least inclination for all models, but the difference is small. Hence IIA, viz. that with the least E. H. P. and the smallest inclination of bossing, is considered the best.

Single screw:—Propulsive coefficient in the case of single screw is the best in III.

M. Kondo.

**5. Means to be adopted in Submarine Boats to add the Safety and for Salvage** (Japanese). Shozo NIWATA. [J. Soc. N. A., 27 (1921), 123–194, with fig.]

A. Internal.

Drop keel and safety tank.

Telephone buoy.

Hose connection for ventilation.

Provision of electric torches.

Fittings for fixing salvage tower.

Blow off arrangements for every tank and compartment.

Means for supplying compressed air.

## B. External.

Salvage vessel with air compressors on board.

Powerful floating crane.

Salvage tower.

Pneumatic hose about 3,000' long.

Submarine electric light.

Acetylene cutting tools.

All other usual fittings for salvage.

M. Kondo.

**6. Action of "Ro".** Seinen YOKOTA. [J. Soc. N. A., 28 (1921), 49-56, with fig.]—The action of "Ro" is investigated and efficiencies are calculated for various attitudes. A virtual water surface is imagined where there would be no slip, and this is taken as the water surface in the present calculations.

For approximation the blade is taken as a long rectangular plate, and Eiffel's results published in his "*La résistance de l'air et l'aviation*" are used to calculate the efficiency.

The efficiencies in terms of  $r$  for several values of constants  $\theta$  and  $\varphi$ ,  $r$  being the ratio of the length of blade to the height of the pivot above water. By drawing cross curves, the values of  $\theta=15^\circ$  and  $\varphi=60^\circ$  appear to give about the most efficient action when  $r=6$  and the efficiency is somewhere near 0.6. These results are in good agreement with general practice.

M. Kondo.

**7. On Improvements in the Ventilating System of Large Warships** (Japanese). Takushiro KAWAHIGASHI. [J. Soc. N. A., 28 (1921), 57-87, with fig. and tables.]—Amount of air required:—Taking the allowable amount of  $\text{CO}_2$  at 7.3 in 10,000 parts of air, 1,800 cu. ft. of air is required to be supplied per hour, giving 6 minutes as the time of renewal if the space allotted to each person is taken at 180 cu. ft.

Proper distribution of air:—Experiments were made to determine the most efficient height of the bell mouth of the supply pipe and its inclination. It was found that the height of 5' above the floor and the inclination of  $60^\circ$  from the vertical were the most efficient, but as this height brings the mouth over the hammocks, a height of 3' to 3'-6'' seems the most suitable.

To minimize the smell and other impurities:—Besides other precautions, care should be taken to avoid leading exhaust outlets from lower living spaces and store rooms into upper living spaces.

To eliminate coal and other dusts:—Every precaution should be taken on this point. Mushroom and similar inlet openings should be provided with efficient means of keeping out all dust, the present design not being considered ideal.

To retain proper temperature and proper amount of moisture:—Besides these, special care is also necessary for the ventilation during summer time.

To keep up the proper circulation of air:—The velocity of the air in circulation should not exceed 500' per minute in sick bays, 1,000' per minute in living spaces and 1,000' to 1,500' per minute elsewhere.

Different methods of ventilation:—Besides the natural ventilation, artificial systems of ventilation are treated.

M. Kondo.

**8. A Patent Paint Undressing Chemical "Flay"** (Japanese). Teichi ISHIBASHI. [J. Soc. N. A., 28 (1921), 141-155, with tables.]—This chemical consists essentially of three ingredients, potassium carbonate, sodium carbonate, and calcium hydrate,



mixed with starch. It is a pale yellow liquid with hardly any smell.

The Flay is useful in removing paints which have animal fat, vegetable fat, wax, etc., as the base, but is ineffective for coal tar, asphalt, paraffin, and such as mineral oils. It cannot remove Japan. M. Kondo.

**9. *The Influence of the Depth of Water on Speed and Power*** (Japanese). Shintaro MOTORA and Tomoyoshi HAGI. [J. Soc. N. A., 28 (1921), 210-211, with fig.]—The results of tank experiments of three models—destroyer, light cruiser, and battleship forms, respectively at different depths of water are given, and the curves showing E. H. P., change of trim and wave profile for several depths of water are given.

M. Kondo.

**10. *On the Effect on the Following Vessel caused by the Presence of the Leading Vessel when running in Line ahead*** (Japanese). Shintaro MOTORA and Tomoyoshi HAGI. [J. Soc. N. A., 38 (1921), 212-216, with fig.]—The results of tank experiments of two similar models of destroyer form in line ahead tried at different distances apart.

The following conclusions were arrived at:—

1. The resistance of the leading vessel is almost entirely unaffected.
2. The resistance of the following vessel is maximum when the middle of her length is situated at the maximum slope of the front part of the transverse wave caused by the leading vessel, and minimum when at the similar position of the back part of the wave.
3. The trim by stern of the following vessel is maximum when the resistance is maximum, and minimum when the latter is minimum.

M. Kondo.

**11. *On the Results of Tank Experiments of a Few Vessels of Special Form*** (Japanese). Takezo YAMAMOTO. [J. Soc. N. A., 28 (1921), 196-209, with fig.]—The results of tank experiments of a few vessels of simplified form, and comparisons are made with the results of vessels of ordinary form, and the differences are discussed.

M. Kondo.

**12. *An Experiment to determine the Effect of Breakage of Propeller Tips on the Efficiency*** (Japanese). Shuzo HASHIMOTO. [J. Hanshin Club, Soc. N. A., 28 (1921), 1-8, with fig. and tables.]—Results of open tests of a model propeller representing a propeller 17'-7½" dia. and 14'-10" pitch run at a constant speed of 200' per min., and of the model cut down to represent smaller propeller. The thrust, turning moment and propeller efficiency are given for each case for various slips.

M. Kondo.

## AERONAUTICS (1-9).

**1. *A New Air Velocity Calculator*** (Japanese). Toyotaro SUHARA. [J. Soc. Mech. Eng. Tokyo, XXIV., **63** (1921), 1-5, with fig. and pl.]—This paper describes a slide rule specially constructed for the purpose of calculating the air velocity  $v$  in a wind channel from the equation

$$v = \sqrt{\frac{1+0.00367t_0}{1.293} \cdot \frac{760}{H_0} 2gh \left\{ 1 + \frac{1}{2\gamma} \left( \frac{h}{f_0} \right) \right\}}$$

in which  $t_0$  is the atmospheric temperature;  $H_0$  the pressure;  $f_0$ ,  $g$  and  $\gamma$  the constants; and  $h$ , the height of water column measured by means of a Pitot and static pressure tube. Corrections of the air velocity for atmospheric humidity are also considered.

Author.

**2. *A Mechanism to indicate on a Uniform Scale the Square Root of a Variable Length.*** Seinen YOKOTA. [J. Soc. Mech. Eng. Tokyo, XXIV., **64** (1921), 19-20, with pl.]—In a right-angled triangle  $ABC$ , if the perpendicular  $CD$  be drawn from the angular point  $C$  of the right angle to the hypotenuse  $AB$ , intersecting it at  $D$ , we have  $\overline{AD} \cdot \overline{DB} = \overline{CD}^2$ , however, the sides might vary in their magnitudes and directions. Now fix both the point  $A$  and the direction of the hypotenuse  $AB$ . Constrain the point  $C$  to move along the fixed line  $CD$  or its prolongation. The distance  $\overline{AD}$  being a constant under these conditions, if we vary the length of the hypotenuse, the corresponding  $\overline{CD}$  represents the square root of the variable  $\overline{DB}$  on a suitable scale. Photographs of a disc-anemometer constructed with this principle are annexed, and applications of this mechanism to a venturi-meter, a centrifugal tachometer and a centrifugal governor are suggested.

Author.

**3. *Aero-Engine for High Altitude*** (Japanese). Kikutaro SASAMOTO. [J. Soc. Mech. Eng. Tokyo, XXIV., **67** (1921), 1-11.]—A description on the thermodynamical efficiency of a high compression engine for altitude flying as affected by the altitude, the compression ratio, and the strength of mixture are given. The efficiency of the turbo-compressor of a super-charged engine is also discussed.

T. S.

**4. *Aeroplane Wing*** (Japanese). Tetsuo NODA. [J. Soc. Mech. Eng. Tokyo, XXIV., **67** (1921), 21-28, with fig.]—A short survey of researches by Prandtl, Kutta and Joukowski is given. Starting from the usual equations for horizontal flight, the author concludes: The necessary properties of aeroplane wings in general are that the ratio of the lift and drag coefficients, and also that the maximum value of the lift coefficient should be large. For a high speed machine the above ratio should be a maximum at a low value of the lift coefficient, while for a climbing machine the former should occur at a possibly high value of the latter. For commercial purposes the intermediate one is preferable. It is impossible to get a wing with a definite section equally suitable for the machines of different types. In connection with the increasing of the speed range, the wings of Handley Page, of variable camber and of variable area are referred.

S. Y.

**5. *Irregularities of Stroke in an Aero-Engine of Radial Type and their Remedy*** (Japanese). Kenji NAKAGAWA. [J. Soc. Mech. Eng. Tokyo, XXIV.,

70 (1921), 1-10, with fig.]—For "V" type engine, the shift of dead-point at the end of compression stroke may be improved by slightly increasing the length of articulated rod. For a radial engine, however, the above method has the practical disadvantage of providing several connecting rods of different lengths. The author proposes to shift the centres of wrist pins suitably, keeping the lengths of connecting rods uniform. The author's method consists in changing the radial distances of wrist pins except those adjoining the master connecting rod. Advantages are that the action of each cylinder becomes uniform and consequently the vibration diminishes and that the construction is easy, and that parts of machine is interchangeable without having any effect upon it. S. Y.

6. *Size, Weight and Horse Power of Aeroplanes.* Kazu SHOGENJI. [J. Soc. Mech. Eng. Tokyo, XXIV., 70 (1921), 45-79, with figs.]—A fundamental equation of equilibrium of similar aeroplanes making a steady horizontal flight is obtained. The maximum useful load to be carried is calculated. The conditions either for minimum traction and maximum range of flight or for minimum power and maximum time of flight are investigated. The effects of the reduction of load during flight on the range and time of flight are discussed. Incidentally it is shown that there are an upper and a lower critical velocity or the largest and the least wing loading for an aeroplane to be flown and a limiting size of aerofoil. The load-distance curves are drawn. Numerical examples are worked out for nearly each case. S. Y.

7. *An Instrument to Measure the Direction and Speed of Wind relative to an Aeroplane* (Japanese). Takuro TAMARU. [Rep. Aeronaut. Research Inst. Tokyo Imp. Univ., I., 1 (1921), 1-23, with fig.]—This instrument makes use of the change of pressure with azimuth on a cylinder exposed to wind, and records it. The cylinder has a diameter of 1.24 cm. and two or three rows of small holes parallel to the axis, the inside space being separated longitudinally. The first instrument was intended to measure directly the angle of side-slip, and trial on "Avro" gave a satisfactory result. The author proceeded to work out a registering instrument. The range of direction of late instrument covers an angle of  $120^\circ$  and registers directly two differences of pressures. S. Y.

8. *Aeronautics in France* (Japanese). Kenji NAKAGAWA. [J. Soc. N. A., 28 (1921), 28-46.]—A short survey of pre-war machines is given. Descriptions of present day machines, flying schools and, research organization follow. S. Y.

9. *Dopes for Aeroplane Fabric* (Japanese). Haruhiko UEMURA. [J. Tokyo Bntsurigakko, 359 (1921), 394-396.]—Chemical compositions of dopes usually applied for aeroplane wings and other parts are described. The most important item governing the quality of a dope is the nature of acetyl-cellulose, and the strength and the tenacity of a doped fabric are largely governed by the degree of solubility of acetyl-cellulose in acetone and by the degree of viscosity of the solution. S. Y.

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## TECHNOLOGY OF ORDNANCE (I).

### 1. *Resistance of Flat Bodies falling upon the Surface of Water.*

Tamotsu AOKI. [J. Soc. Mech. Eng. Tokyo, XXIV., 70 (1921), 93-136, with fig. and tables.]—This paper constitutes the first report of the experimental work still in progress. The present investigation was undertaken in order to discover the law of resistance which acts on a body falling upon the surface of water, at and near the surface. The velocity of fall was measured by means of a tuning fork and spark gaps 10 cm. apart vertically each other. The resistance was formulated from the change of velocities. A square plate, a rectangular plate and a cylinder with their bases horizontal were experimented upon, and empirical formulae were suggested for the mean resistance estimated for 5 cm. depth from the surface of water. The variation of resistance with the depth was also investigated.

Summary of the main results of this experimental work:—

- 1) The resistance at the instant of contact of the flat bodies with the surface of water seems infinitely great.
- 2) The resistance, however, decreases rapidly as the depth increases.
- 3) Within a depth which is a comparable fraction of the dimension of a model, the resistance becomes finite.
- 4) The velocity, after a certain depth is reached, decreases linearly as the depth increases.
- 5) The resistance near the surface of water is proportional to a certain power of velocity; but this law changes with increase of depth.

Author.

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## ELECTRICAL ENGINEERING (1—46).

1. *On the Electric Arc Welding* (Japanese). Takeshi OKAMOTO. [J. Elec. Eng. Soc. Japan, XLI., 391 and 596 (1921), 109-136 and 511-521, with fig. and phot.]—In this paper the first chapter deals with the characteristics of the arc, the chemical and physical phenomena occurring in the process of welding and metallographical investigations chiefly from the point of view of the practical application of the alternating current metallic arc welding. In the second chapter, the characteristics of the metallic arc, that is, the relation between the arc current and the rate of the electrode consumption, the relation between the current and the electric power developed in the arc, and the relation between the current and the arc voltage, are shown both by curves and empirical formulae deduced from the results of a number of experiments. And also the oscillographs of the wave forms of the arc current and voltage and the phase relation between them are shown, and the difficulties accompanying with the alternating current arc welding are explained from them. In the third and the fourth chapters, the chemical and physical phenomena, chiefly in connection with the formation of the slag and blow holes, are treated. In the fifth chapter the physical properties of the deposited and the original metal which is adjacent to the deposited metal are discussed from the microstructures. The metallographs of the original metal (steel plates) at distances 1, 2, 3 mm. etc. from the boundary are shown, and the physical properties of these parts are rather improved, and also the metallographs show that the boundary between the deposited and the original metal is in a cast condition, and the strength is weaker than the original metal, but on account of the inclination of the line at  $30^\circ$  or  $45^\circ$  this deficiency of the strength does not impair the total strength of the weld. The author concludes that the weakest part in the case of the welded steel plate exists in the deposited metal and proposes some methods of remedy.

2. *Economical Design of a Transmission Line* (Japanese). Ryotaro MITSUDA. [J. Elec. Eng. Soc. Japan, XLI., 392 (1921), 181-106, with fig. and tables.]—Determinations of principal parts of long distance electric power transmission lines, such as electric voltage, diameter of conductors, dimensions of iron towers etc., were discussed on the economical point of view. First, principal terms of economical power transmission were treated thoroughly, and secondly, fundamental equations to calculate the expense of power transmission and its minimum condition were determined by applying the circle diagram methods of calculations. The expense of power transmission is the sum of the cost of electric power loss and the expense relating to the capital invested, and it is very convenient to express it in the percentage of the original price of electric power. In the process of calculation, each economical factor is expressed mathematically and practically as a function of three independent variables of transmission voltage, diameter of conductors, and length of span of iron towers, specially as for the estimation of iron towers the practical calculations were performed, expressing the complicating terms in the simplified equations, and then electric voltages, diameters of conductors, and dimensions of iron towers were determined by calculating the practical cases of many transmission lines, and also the relations between these terms of design and transmission of power, distance and original cost of power were mentioned. These are all mutual in the economical sense, for instance, larger electric



power and longer transmission distance require higher voltage, larger conductors and larger iron towers, and for higher original cost of electric power expense of transmission due to electric power loss will become comparatively important, and in this case higher voltage and larger conductors become economical. Values of voltage and diameter of conductor determined as above were found frequently to agree with requirements of corona formations, specially for larger electric power the conditions of corona formation must be taken in the consideration, because diameter of conductor will not be taken as proportional to the voltage.

In this case the most economical design will be performed in the range of corona condition by using the curves which show mutual relations between voltage and conductors economically. The equations of corona formation derived by Peek is too complicated in its form to be used in practical case. But, in practice, as the distance between conductors is taken proportional to the voltage, such as about one foot per ten thousands volts, corona voltage will become proportional to the diameter of conductor. In comparing these results of calculations to the Still's equations of relations of transmission voltage, power and distance, if we assume original cost of electric power in the Still's equations, there are found very close identification; but for larger power it must be noticed that the voltage obtained from the Still's equation is too high, and the above method of calculation may be used to determine the economical limit of increasing power supply by changing power factor, using the synchronous alternator in the transmission line, but it is not economical to take too high power factor.

**3. The Use of Synchronous Condensers in Connections with Long Transmission Lines** (Japanese). Yasuke ANZO. [*J. Elec. Eng. Soc. Japan*, XL1., 392 (1921), 155-179, with fig.]—It is well known that most equipments of generation, transmission and distribution will require to supply a certain amount of electrical power, if there is, the lower power factor due to several causes in the alternating current circuit. As for this remedy, it was suggested to improve the power factor of machines themselves or to improve it by using either condensers or synchronous advancer in parallel. At first, as a method to consider the effect of power factor on the transmission three kinds of circular diagrams were discussed, because circular arcs can express relations of power, voltage and current at the both ends of power transmission line. In these diagrams it is shown that power factor in the transmission line has very prominent effects on the voltage drop, capacity, and efficiency of the line, and as it was found that the capacity of the transmission will be changed especially by power factor, and not by the diameters of the conductors, it is necessary to design the phase advancing devices in the long distance transmission lines. In America, it was said that the power factor was improved to about 100% in a few practical lines. In using synchronous advancer as phase advancing device in the long distance transmission line, many difficulties due to the large amount of charging current will be removed and also there will be obtained the so-called constant potential or the most economical power transmission.

In the Inawashiro Electric Power Company two synchronous advancers were used to comply with the increasing demands of electric power supply, by increasing the capacity of the present transmission line, and they also gave some convenient methods to examine and to replace poor insulations in the line. It was proved that there is a substantial agreement between the results from the above mentioned circular diagrams and the practical results; and considering the synchronous condenser as a portion of transmission line and

starting it, at the same time, with generator, we can eliminate almost all of operating troubles by changing the amount of the charging current of transmission lines, adjusting the synchronous condenser. Finally, the few examples of practical regulations of power factor in the United States of America and Canada were explained.

**4. On the Precipitation Treater with Glass-covered Electrodes** (Japanese). Motoharu SHIBUZAWA and Yasujiro NIWA. [J. Elec. Eng. Soc. Japan, XLI, 393 (1921), 245-260, with fig.]—The details of experiments on the precipitation treater with glass-covered electrodes at the Nikko Electrical Copper Refining Factory were presented, and this method was proved to be better than the methods already adopted in the vibration of the electrodes, discharge between the electrodes, corona phenomena and required power outputs. Next the theory of this method is considered, and discussed electrostatically the potential gradient in the precipitating tube, and compared this calculated result with the experimental data. Lastly the phenomena in which the comparatively larger currents were flowing through the insulating material, were mentioned and explained as the results of decrease of resistance due to the temperature rise, and the potential gradient in the insulation, and the increase of potential gradient due to free charge on the surface of the insulator.

**5. Rotary Induction Converter** (Japanese). Hajime MARUYAMA. [J. Elec. Eng. Soc. Japan, XLI, 393 (1921), 266-279, with fig. and tables.]—The object of this paper is to introduce the rotary induction converter the author designed, and the subject is treated under the following headings.

I. Introduction:

1. Explanation of the name of the machine "rotary induction converter."
2. Similar machines already made.
3. Uses of the rotary induction converter.
4. Practical examples of a.c. motorgenerators for wireless telegraphy used in ships.
5. Comparisons between rotary induction converter and a.c. motorgenerators.

II. Rotary induction converter:

1. General construction.
2. Induced electromotive force and voltage ratio.
3. Voltage regulation.
4. Regulation of frequency.
5. Starting and stability of running.
6. Commutation and range of capacity.

III. Experiments of the induction rotary converter.

**6. "Elliptic Locus Method" to determine the "Regulation" of a Salient Pole Synchronous Generator.** Kumeo BABA. [J. Elec. Eng. Soc. Japan, XLI, 393 (1921), 321-336, with fig. and tables.]—It is the object of this paper to describe a new method for the close determination of the field exciting current of three phase salient pole type synchronous machines at any specified p.f., and to make its use directly in the case of their design. Since the machine of this type has been developed several decades have passed and numerous papers have been appeared on the subject, but there is very little convenience of the predetermination of field m.m.f. especially at low p.f.

load. It is also shown that the voltage regulation at any p.f. can easily be obtained from the exciting m.m.f. so determined, with the combined use of the well known no load saturation curve. Principal feature in this paper is based on the experimental data that the m.m.f. vector of the loaded armature reaction describes an elliptical locus when its p.f. is varied and the load kept as constant. Chief methods hitherto published will probably be those adopted in the Standard of A.I.E.E. and that of the Blondel's so-called two reaction method. In section I, brief descriptions are given on these methods just mentioned, classifying as m.m.f. vector and e.m.f. vector, and showing that these are all to put into circle diagrams. Besides, it is shown that the decomposition of the armature reaction into two components, corresponding to unity p.f. and the other to zero p.f. has some values in design, but it is too complicated for rapid practical application, and not so adequate in testing the voltage regulation. In section II, there is described the advantage of the new elliptic m.m.f. method proposed by the writer over any other ordinary methods in its simplicity and in its close agreement with the actual test results. It is pointed out there that the transformation coefficient of the armature reaction into field m.m.f. frequently referred by some continental writers, is not so strict. Finally, some results of actual tests together with those obtained from the proposed method are shortly given to show its degree of precision.

Author.

**7. Insulators for Extra-High Voltage Transmission.** W. A. HILLEBRAND. [*J. Elec. Eng. Soc. Japan*, **XLI**, 395 (1921), 391-410, with fig. and phot.]—Insulators, as used in present day practice, are a product of many years of experimenting and numerous unfavorable experiences. The art of manufacturing has been so perfected that a rate of depreciation of less than  $\frac{1}{50}$ th of one per cent. per annum had been reached. The insulating materials in present use are of two classes, hydro-carbons and silicates. The latter, which includes glass and porcelain are used for outdoor service, but glass, because of its characteristics, is little used.

Porcelain used in American practice is made up of clay and potash feldspar, which acts as a binder. Great deal of attention must be paid to proper firing, adequate vitrification, purity and fineness of raw materials, factory organization, etc. in order to produce a uniform grade of porcelain of high quality. The manufactured porcelain insulators are all given an electrical potential test to weed out the defective ones. The test usually consists of applying high frequency peak voltage many times over flashover value at normal frequency.

There are now three types of porcelain suspension insulator used extensively; interlink, tension, and cap-and-pin types. The last named type is used in overwhelming numbers, because of its superiority, both mechanically and electrically, over the other two. It is now generally believed that with the increase in the voltage of transmission lines, this type will be more extensively used.

In many systems, grading of insulators is resorted. Theoretically, grading will equalize the voltage duty among the several units of the string, but in service, it has been borne out that grading takes care of only one condition, namely with the insulators dry and clear. Additional objections in adopting this method are the increase in the first cost and that in the maintenance cost. The most common practice today is to make the insulator nearest the conductor large enough to withstand the stress and make the rest of the same size. This will be cheaper from manufacturing standpoint as well as from the standpoint of keeping spare units.

There are two factors which governs the selection of number of units per string, namely the distance from conductor to cross arm and the rate of depreciation of insulators. The first item is well understood, but the second factor could be only approximated by the use of law of probability. Anstin and Klanber's formula appearing in the Transaction of the American Institute of Electrical Engineers seems to give pretty close results.

After the insulators are put in service, at certain intervals, insulation tests are sometimes carried out to determine their condition. Three methods of testing are in common use; megger, "buzz stick" and spark coil. The megger method is most widely used and is quite efficient, but this and the spark coil method require the line to be taken out of service. At the present time, there seems to be no satisfactory method of testing pin type insulators. Visual inspection and the use of telephone receiver in the case of wood poles are the only methods at all effective.

The use of ground wire is a much debated question today. Many new lines installed recently did not put in the ground wire on the ground that better results will be secured by putting its cost into additional insulation.

The practicability of using wood poles with suspension insulators is also under study. In using wood poles, the rate of decay of wood must be balanced against the element of cost. In a certain instance, a 110,000 volt line was put in with wood poles, but the result of operation has not yet been made public.

Author.

**8. *A Converter with Revolving Field and Revolving Brushes* (Japanese).** Hitoshi SHIHO. [J. Elec. Eng. Soc. Japan, XLI, 395 (1921), 439-452, with fig.]—A Special A. C.—D. C. converter, using the principle of a polyphase induction motor with its revolving field was recently brought to the attention of the engineering circle. To obtain direct current from this machine A. C. power is applied to the stator, and the brush gear is rotated at synchronism about the commutator attached to the rotor which is stationary. The position of the brushes is automatically adjusted in such a way as to give maximum potential difference between the positive and negative brushes.

The theory of operation, with mathematical analysis and general description of the converter, is given in the paper. The author holds the patent for this new machine.

Author.

**9. *Co-ordination of Electric Power Systems*.** Motoharu SHIBUZAWA. [J. Elec. Eng. Soc. Japan, XLI, 395 (1921), 367-382, with fig.]—The co-ordination of the electric power systems in Japan is one of the most important post bellum measures worthy of serious consideration.

At the present time, almost all industries had been electrified but there remains to be seen, in the near future, the electrification of main railways and electrical ship propulsion.

During the war, the interconnection of electric power systems was much discussed and adequate measures had been adapted in various countries in the world.

In Japan the necessity of interconnection of transmission lines was discussed many years ago, and the electrical enterprises law was amended in 1916, adding an article which gives the right to the Government to force any two or more corporations to tie their lines when the Government finds it necessary for the public benefit. Although the original intention of this amendment was to minimize the case of shut-down of transmission lines, it stimulated the interconnection from economical point of view such as for utilizing



surplus water and saving coal. Consequently, since that time, many of the power systems are voluntarily interconnected, this course having often being suggested by the Government. Recently after the war, various power corporations are frequently amalgamated, and complete co-ordination will be carried out.

To bring about the coordination of electric power systems many difficulties must be surmounted. Without clear analysis and definite understanding of the subject, the task of unifying the systems will result in a dismal failure. Thus, the co-ordination of power systems should be carried out so that the following advantages can be really obtained and if it has been actually already done, the benefit therefrom should be distributed to the public.

Author.

**10. On Radio System of High Power Station in U.S.A.** (Japanese). Toyokichi NAKAGAMI. [J. Elec. Eng. Soc. Japan, XLI., **395** (1921), 382-390, with maps, pl. and phot.]—In America, most high power radio stations use continuous wave for transmission. Station with spark coils for transmission and coherers for reception of messages are decreasing in number. The Radio Corporation of America is using Alexanderson's high frequency alternators and the U. S. Navy Poulsen arc for radiating continuous waves.

Author.

**11. Automatic Telephone Switchboard System** (Japanese). Yukiomo YAMANE. [J. Elec. Eng. Soc. Japan, XLI., **395** (1921), 411-432, with fig.]—The development of automatic telephone switchboard in America and Europe is given chronologically, and the descriptions of various types used in present day practice. The Strowger and Western Electric Rotary types used most extensively in cities with approximately 3,000 subscribers and the Panel switch type in larger cities are carefully analyzed.

Mechanical construction and theory of operation of Western Electric Panel Type telephone switchboard are given in detail, and the paper is concluded with advantages derived by using the automatic telephone.

Author.

**12. The Firing of Pulverized Coal** (Japanese). Noboru KISHI. [J. Elec. Eng. Soc. Japan, XLI., **396** (1921), 455-496, with fig. and tables.]—The article deals, first, with the historical development of the art of burning pulverized coal in the furnace and the present day tendency in its use. The advantages derived by the use of pulverized coal and the results of actual test are carefully discussed. Later on the author describes the construction of the more important parts of the pulverized coal plant, and compares the relative merit of the various types of plants now in service. The last part of the paper shows the economics of pulverized coal plant and factors to be considered in the selection of the type of plant.

Author.

**13. On Some Home-made Triodes** Hideji YAGI. [J. Elec. Eng. Soc. Japan, XLI., **296** (1921), 497-510, with fig.]—This is the report of tests, of some home-made triode vacuum tubes, carried out in the Tohoku Imperial University about eighteen months ago.

The static characteristics are first given, from which the operational constants such as "Mutual Conductance," "Amplification Constant," etc. are derived.

After reviewing the behavior of the different types of tubes, some essential points are brought out about their design.

The author then experimentally studies how the mutual conductance varies with the



filament heating. The "Lumped Characteristics" of two entirely different kinds of triodes are plotted, as suggested by Prof. Eccles.

The photograph of the triodes under test is reproduced.

Author.

**14. Electromagnetic Induction and the Effective Self-Inductance of a Straight Transmission Line with Earth Return, and the Potential Difference on the Earth Surface.** Hidetaro HO. [J. Elec. Eng. Soc. Japan, XLI., 396 (1921), 522-530, with fig.]—With the assumptions that the earth has a uniform specific resistance, and that the stream-lines of current of commercial frequencies in it may be taken approximately as those determined with resistance only taken into account, it is shown that the EMF induced by a varying current in a straight transmission line with earth return, in a conductor one cm. long parallel to the line at a point  $p$  distant  $y_0$  cm. from the line, may be expressed by

$$-\left(\log \frac{y_0}{\sqrt{x^2 + y_0^2} - x} + \log \frac{y_0}{\sqrt{z^2 + y_0^2} - z}\right) \frac{di}{dt} \quad (\text{e. m. u.})$$

$x$  and  $z$  being the distances from the two ends of the line to the foot of the perpendicular from  $p$  to the line.  $x$  or  $z$  is to be taken negative when  $p$  is outside the line in either direction. Integrating this, the total EMF induced in a parallel line is obtained. As a result of application of the formula, the self-inductance of a single-conductor straight transmission line with earth return is shown to be

$$L = 2D \left( \log \frac{2D}{r} - \frac{3}{4} \right) \quad (\text{e. m. u.})$$

where  $D$  is the length of the line,  $r$  is the radius of the conductor. Lastly, the potential difference on earth surface is expressed in terms of the electrostatic capacities of the electrodes.

Author.

**15. Engineering Education in an Electrical Manufacturing Workshop in America** (Japanese). Tatsuo ISHIYAMA. [J. Elec. Eng. Soc. Japan, XLI., 397 (1921), 541-545.]—Marvelous advancements are now being made in America with regard to the manufacturing arts of electrical machinery. They are constantly trying new methods, thereby furnishing new or improved articles in the market. Needless to say, there are a great multitude of highly educated and experienced engineers, "behind the gun." These eminent engineers, however, cannot be brought about easily. It is believed by the author that the methods of fostering young engineers, adopted by the Westinghouse Electric and Manufacturing Company, are undoubtedly worthy of attention of the electrical circle in Japan. Educational systems suitable for the different classes of graduates are stated in this paper.

Author.

**16. Iron Wire in Japan** (Japanese). Suketsugu KIMURA. [J. Elec. Eng. Soc. Japan, XLI., 397 (1921), 546-577, with fig., phot. and tables.]—The author states the present day condition of the iron wire in Japan, mainly from the standpoint of telephone and telegraph engineers. The contents will be classified as follows:—

1. Introduction.

2. }  
3. } Process of manufacturing of the iron wire and the various factors to be considered  
4. }

during its course.

- 5.} The effect of annealing on the iron wire just drawn.
- 6.}
7. Japan has succeeded in manufacturing the iron wire of high quality.
8. Remarks on Specifications.
9. Various forms of the zinc coating and its resistivity to corrosion.

**17. *The Effect of Some Acoustic Loads on Telephone Receivers*** (Japanese). **Kanesaburo KUROKAWA**. [J. Elec. Eng. Soc. Japan, XLI., **397** (1921), 578-603, with fig.]—It is well known that the electric impedance of the telephone receiver is affected by the motion of diaphragm, which in turn depends upon the condition of air space adjoining to it. This fact was made clear by the author's experiments; *i. e.* it was shown how the electric impedance of receiver circuit was changed by applying the ear to a receiver or by placing a long pipe in front of it. Moreover, in the latter experiment, the test results may well be explained by means of "acoustic impedance" theoretically deduced. A few instances of practical applications resulted from the author's experiments are also discussed. Author.

**18. *Some Application of Difference Equations in Electrotechnics*** (Japanese). **Tetsutaro MIYAZAKI**. [J. Elec. Eng. Soc. Japan, XLI., **397** (1921), 604-623, with fig.]—In finding a solution for electrical problems mathematically, one frequently runs into unrelated terms. The author advances the theory that, by the use of difference equation, more reasonable solution will be obtained. With a simple difference equation for transmission circuit which can easily be changed to a straight line function, a few examples of the general application of the difference equation are given for suspension insulators, multi-gap arresters, distribution of potential in the transformer windings, wave filter and loaded cables. Author.

**19. *On the Invention of the "Revolving Type Electric Meter"*** (Japanese). **Hideo MATSUMOTO**. [J. Elec. Eng. Soc. Japan, XLI., **398** (1921), 704-707, with fig.]—It is well known that working energy of the electric meters has been limited to only two of the electric and the magnetic energy, and the difficulty of the construction of high sensibility meters and the expensiveness of these price are mainly owing to the limitation of the working energy. The author recently invented a new electric meter, the "Revolving type electric meter," and obtained a patent (Registered No. 38921). The following article gives the statement of its theory and constructional principle:— In this meter the mechanical energy is easily used as the working energy in addition to the electric and the magnetic energy, by the constant speed separately excited generator principle, and its theory and principle can be effectively applied for the wide range of electric meters and measuring instruments. Author.

**20. *Powdered Coal as a Fuel for Stationary Boilers in America*** (Japanese). **Kanichiro KITA**. [J. Elec. Eng. Soc. Japan, XLI., **398** (1921), 649-689, with fig. and tables.]—The development in the utilization of powdered coal as a boiler fuel in America has been so marked that the attention of power plant experts of the world has been focussed there. The Fuel Research Board of London even went so far as to send a specialist to the United States to investigate the actual working conditions of the various powdered coal plants. This paper deals, in the main, with the following topics:—

1. The extent of use of powdered coal at power plants in America.

2. The equipments used in plants burning powdered coal.
3. Some of the difficulties encountered and overcome in its use.
4. The first cost, operating and maintenance expenses of various types of powdered coal plants now in operation.

Author.

**21. On the Construction of Alexanderson Extra High Frequency Generator** (Japanese). Hikoto MARUYAMA. [J. Elec. Eng. Soc. Japan, XLI., 398 (1921), 625-634, with fig. and phot.]—In manufacturing high frequency generators of large capacities, numerous difficulties must be surmounted. The difficulties are not only mechanical, but also electrical, and these are pointed out very vividly. The constructional details of a new 400 K.V.A. Alexanderson Extra High Frequency Generator, built by the Shibaura Engineering Works under Japanese patent are given with test results. The author concludes with his personal impression of the new generator.

Author.

**22. Stay and Stayed Structures** (Japanese). Yoshio SHICHIRI. [J. Elec. Eng. Soc. Japan, XLI., 398 (1921), 635-648, with fig.]—Solutions of various stayed structures for line supports are given, and the most economical angles of the stay are discussed in this article.

At first, for single poles, the most economical angle is calculated, and then calculations are tried for the complex case considering the bending of poles.

In the third and the fourth parts, H-poles and A-poles are treated respectively.

In the fifth part, wide base towers are treated, and solution of the complex structures is performed by using the displacement diagram of the towers.

Results of these several cases are discussed, and the article is concluded. It is the author's opinion that the most economical angle of the stay is less than 45 degrees; it is somewhat 30 degrees in general.

Author.

**23. Nationalization of Electrical Power Plants** (Japanese). Shigekane TADA. [J. Elec. Eng. Soc. Japan, XLI., 398 (1921), 700-703.]—A few years ago, the author advocated the co-ordination of electrical industries of the empire, and this in turn opened the path for the discussion of the nationalization of power plants. The problem of nationalization is treated in the paper not from the popular view points of economy and industry, but from the standpoint of policy of the human society. It is the author's firm conviction that, as the natural resources, water and coal, which are necessary for the generation of heat, light and power—all absolutely essential to men—are limited in quantity, the society should control the power plants for the benefit of its members. The following two points are advanced to make a success of the nationalization:—

1. The generated power to be distributed to the people on the profit sharing basis at a reasonable figure per KW.
2. The management to be in the hands of a special committee invested with absolute power.

The author believes that the present tendency of amalgamation of power companies will only be new power to the already supreme capitalism and is a hindrance to nationalization.

Author.

**24. On the "Revolving Type Electric Amplifier" and the "Revolving Type Electric Relay"** (Japanese). Hideo MATSUMOTO. [J. Elec. Eng. Soc. Japan,

XLII., 398 (1921), 705-709, with fig.]—The author states the principle and the construction of a new electric amplifying apparatus "Revolving type electric amplifier" or the "Revolving type electric relay", which has been designed by the same principle of the "Revolving type electric meter" (Patent No. 38921), and its speciality is that it has no spark or arc gap in the working device.

Author.

**25. Some Notes on Recent Progress of American High Tension Insulators** (Japanese). Heiji TACHIKAWA. [J. Elec. Eng. Soc. Japan, XLI., 398 (1921), 690-699, with fig.]—This paper primarily deals with the high tension insulators of present day as was noted by the author during his recent visit to the United States. Expert opinions of transmission specialists and leading manufacturers are the basis of this paper. A part of the contents was presented as a discussion of the paper on "Insulators in High Voltage Transmission" by Mr. W.A. Hillebrand, at the June meeting of the Tokio branch of the Institute.

The subject is presented according to the following headings:—

1. Materials for insulators.
2. Improvements in the pin type insulators.
3. Comparative study of typical suspension type insulators.
4. Improvements in the cap-and-pin type insulators.
5. Comparison of clevis joints and ball-socket joints.
6. Depreciation of insulators.
7. Methods of weeding out defective insulators.
8. Method used in changing defective insulators.
9. Protective methods used for insulators.

Author.

**26. Principle of Continuity of Vector Power in an Alternating Electromagnetic Current Field** (Japanese). Heiichi NUKIYAMA. [J. Elec. Eng. Soc. Japan, XLI., 399 (1921), 765-796, with fig.]—As a general case of an alternating current problem, an alternating electromagnetic current field is treated in which the rectangular components of each vector quantity, such as the density of electric and magnetic current, are considered as complex harmonic functions of time. Special attention is given to the problem of complex average power or vector power. As a method of analysis of such a problem, the symbolism of electrical vector power product, complex scalar product, complex vector product, etc. are proposed. The analysis is reduced to the calculation of complex effective vector fields and complex effective scalar fields, that is, symbolic vector and scalar fields. This is an extension of the symbolic method to a space problem. The equations expressing the law of continuity of true electric current and true magnetic current and also Maxwell's fundamental equations of electromagnetic field are given in symbolic form. The phenomena of dielectric and magnetic hysteresis in revolving ellipsoidal electric and magnetic field are discussed under the conception of fundamental ellipse of the hysteresis loop, and the expressions of hysteresis loss and average stored energy in such fields are given in symbolic form. The symbolic vector fields of electric intensity and magnetic force are decomposed into curl field, divergence field and impressed field. This result is applied to the decomposition of vector power density, and thus the fundamental equation of vector power in a complex harmonic electromagnetic current field is obtained in its symbolic differential form. Applying Gauss' theorem in the symbolic vector field of the vector power equation, it is converted into the following integral form.



$$\begin{aligned}
& f(\dot{\mathbf{V}}_e \cdot \dot{\mathbf{I}}_e) ds + f(\dot{\mathbf{\Psi}}_e \cdot \dot{\mathbf{\Omega}}_e) ds + \frac{1}{4\pi} f(\dot{\mathbf{G}}_e \cdot \dot{\mathbf{H}}_e) ds \\
& + f(\dot{\mathbf{G}}_0 \cdot \dot{\mathbf{I}}_e) dv + f(\dot{\mathbf{\Psi}}_e \cdot \dot{\mathbf{H}}_0) dv \\
& = f \mathbf{P}_c dv + f h_a dv + f h_b dv + j2\omega [f \tau dv - f u dv]
\end{aligned}$$

This equation, by the author's opinion, can be best explained as a principle of continuity of vector power in an alternating electromagnetic current field. As a simple case of technical application of this principle, the vector power equations for network of linear electric circuit, linear magnetic circuit and linear electromagnetic circuit are deduced.

Author.

**27. Burning Powdered Coal in Boiler Furnaces** (Japanese). Kanichiro KITA. [J. Elec. Eng. Soc. Japan, XL1, 399 (1921), 713-740, with fig. and tables]—The successful combustion of powdered coal in boiler furnaces can only be obtained by proper design of the combustion chamber, and by the suitable method of feeding the fuel and air. Many a failure of the powdered coal plants can be traced back to these two conditions. In this paper, the author tries to make a comparison of the combustion of powdered coal with that of ordinary method, and points out the important factors to be considered in the construction of the furnace. The subject is treated under the following headings:—

1. Combustion of powdered coal.
2. Thermal efficiency.
3. Coal suitable for use in the powdered form.
4. Explosion and its protection.
5. Spare equipments and length of stowage.
6. Conclusion.

Appendix. Reference literatures.

**28. Few Notes on the Characteristics of Load Saturation Curves of Three Phase Alternators, at Power Factor Zero** (Japanese). Jutaro TAKEUCHI. [J. Elec. Eng. Soc. Japan, XL1, 399 (1921), 759-764, with fig.]—Various methods are suggested to predetermine a load saturation curve at power factor zero, however it seems almost impossible to predetermine an armature reaction at full voltage from the short circuit tests. Torda-Heymann's method is widely adopted for the predetermination of a load saturation curve at power factor zero, in which the armature reaction at full voltage and power factor zero is supposed to be  $i_s f(R)$ , where  $i_s$  is the field current to overcome an armature reaction on short circuit. Dr. Torda-Heymann has suggested that the value of  $f(R)$  can be represented by  $\left(\frac{R}{R_s}\right)^2$ , where  $R$  is the reluctance corresponding to the actual saturation and  $R_s$  is the lowest limit of reluctance with no saturation.

The author has tested a few actual machines and found that  $f(R)$  can not be represented in a form  $\left(\frac{R}{R_s}\right)^2$ , or even in the general form  $\left(\frac{R}{R_s}\right)^n$ , that the value of  $n$  is not constant (varies from 1.2 to 2.3) even for the same machine and depends upon a degree of saturation. But we can find a very interesting character of the saturation curve, by a close observation of our experimental results, that the actual value of  $f(R)$  is almost independent of armature reaction and only depend upon the actual point of saturation at which the resultant flux is working. From this result, we can determine the full load saturation



curve at power factor zero by measuring a saturation curve at lower load current at power factor zero, or obtaining armature reaction at load current, and increasing this armature reaction by the ratio of the load current to the supposed full load current. Author.

**29. Recent Electrical Developments in America** (Japanese). Seichi YOSHIMI. [J. Elec. Eng. Soc. Japan, XLI., 399 (1921), 741-758, with fig.]—This paper may be considered as a report of the investigations of the various electrical industries in America conducted during his sojourn there. It is of special interest as it takes up the points not covered hitherto by other engineers who have visited America. The paper includes the following topics:—

1. The use of pulverized coal; benefits derived thereby; operation; fear of spontaneous combustion; test results.
2. Parallel operation of hydro-electric plants as was evidenced in Southern Power Co.'s and Central Maine Power Co.'s systems reliability and continuity of service resulting therefrom; delta versus star connections; importance of relays.
3. Automatic generating stations of the Turners Creek Power Co. and the Iowa Railway and Light Co.
4. Comparative study of cap and pin type insulators, Hewlett type and J. D. type; depreciation rate; significance of laying emphasis on mechanical strength; tunnel kiln for firing.
5. Aluminum cell arresters; method of maintenance; oxide film arrester and its weakness.
6. Arc suppressor recently brought out by Mr. Creighton of G. E. Co. Author.

**30. Aluminum Cell Arresters** (Japanese). Kumazo MUROZUMI. [J. Elec. Eng. Soc. Japan, XLI., 400 (1921), 799-812, with fig.]—To protect transmission systems from lightning and static disturbances, the use of arresters is most important, and great deal of attention must be paid to see that their function is properly. There are two essential properties which should be inherent in the arrester to make it virtual safety valve: first, it must offer a very high resistance to the flow of current at normal voltages and a very low resistance to ground at abnormal voltages, the change of resistance being instantaneous with the change in voltage; secondly, it must be a condenser so that its effective resistance to ground to current at normal frequencies is great, but that to current at high abnormal frequencies is small. Aluminum cell and oxide film arresters possessing the above two qualities have given great deal of satisfaction to transmission companies, and are used very extensively. However, in very high voltage and large capacity stations, the aluminum cell arresters are used exclusively.

In Japan, most of the aluminum cell arresters now in use, had been bought from the General Electric and the Westinghouse Companies, but very recently arresters manufactured by the Hitachi and the Yasukawa Companies have appeared on the market. But it was many years of experimenting and study that made the manufacture of satisfactory commercial arresters in this country possible. The greatest difficulty was encountered in building thick film on the surfaces of the aluminum trays. The author tells what means had been devised to obtain the desired result. Author.

**31. The Electromagnetic Induction and the Self-Inductance of a Transmission Line with Earth Return** (Japanese). Part II. Hidetaro Ho. [J. Elec. Eng. Soc. Japan, XLI., 400 (1921), 813-815, with fig.]—As the continuation of the

author's former paper in the July number of the Journal, it is shown that the electromagnetic induction due to a transmission line with earth return, which is in form any arbitrary combination of straight lines, can be calculated by applying the formula obtained for a simple straight line to each straight portion of the given line and summing up the results. Method of calculating the effective self-inductance is also shown. A few corrections of the former paper suffixed.

Author.

**32. *On the Temperature Rise in Lead Accumulators*** (Japanese). Etsuro ISHII. [J. Elec. Eng. Soc. Japan, XLI., 400 (1921), 816-823, with fig.]—It has been generally conceded by battery specialists that temperature above 38°C. in lead accumulators lessens the life considerably. Numerous experiments conducted by the author with the "Excide" battery have shown, however, that even above this temperature, the life of the accumulators is not much affected. It was also proved that there is a most economical temperature for accumulators, and this is dependent on acid density. The latter part of this paper is taken up by the author's theory of temperature rise in lead cells and its relation to temperature of the surrounding air, density of the acid solution, current density and the method used for cooling the cells. Sufficient experimental data are presented in this paper for reference.

Author.

**33. *Nationalization of Electrical Power Plants*** (Japanese). Hisao MATSUOKA. [J. Elec. Eng. Soc. Japan, XLI., 400 (1921), 836-841, with fig.]—This paper gives an adverse view of the paper on "Nationalization of Electric Power Plants" presented by S. Tada of the September meeting of the Institute. The author makes it very plain that an important subject such as this should not be treated merely from the financial standpoint. He gives his view on the amalgamation of electric power plants and the uniform power rate system. In short, this may be regarded as a discussion of Tada's paper.

The main portion of this paper may be summarized as given here below. The relation between the natural resources of the country and the generation of electric power and their bearing on modern industrial activities are treated in a great length. He reviews the fuel problem, the plans of river improvement, the forestry policy, the question of railway electrification and the plans of national defence as having close connections with the nationalization of electric power plants. He further advances the idea that coordination of power plants will bring about efficient utilization of electric energy, and will bring along with it lower power cost hence more complete electrification of industrial plants and greater application of electricity to houses and appliances. All these are in accordance with the program of socialization of public utilities which is being received so enthusiastically as an absolute necessity by the Japanese people. It is the author's firm conviction that nationalization will alone bring about the desired result.

Author.

**34. *Future Development of High Frequency Communication System in Japan*** (Japanese). Eijiro TAKAGISHI. [J. Elec. Eng. Soc. Japan, XLI., 400 (1921), 824-835, with fig.]—The subject matter is treated in three sections. The first section deals with the wonderful development and improvement that are possible in the vast communication system of this country by the use of vacuum tube. Our attention is paid to the necessity of improvement in the existing land and ship radio stations, and installation of various stations based upon this new principle, e.g. wired and wireless stations, exchange offices for wired and wireless messages, etc.

The second section is taken up by the author the theory of the vacuum tube of large capacities and the design of such a tube is discussed. The author brings out the fact that manufacture of powerful tubes is an immediate necessity in this country and should be given a great deal of consideration.

In the third section, designs of high frequency telephone and telegraph apparatus with a connection diagram are given together with the author's comments and explanations. The paper is concluded with a plea that those interested in the development of communication work in Japan should cooperate to attempt an immediate realization of the establishment of high frequency communication system with vacuum tubes. Author.

**35. *On the Colour-blindness*** (Japanese). Shinobu ISHIWARA. [J. Ill. Eng. Soc. Japan, V., 1 (1921), 33-40, with fig. and phot.]—A medical paper treating briefly the colour-blindness for illuminating engineers.

**36. *Relation between Illumination and Internal Decoration*** (Japanese). Seigo MOTONO. [J. Ill. Eng. Soc. Japan, V., 2 (1921), 99-108, with phot.]—There are two different views for the problem of illumination the one from the industrial aspect, and the other from the standpoint of art.

The author discussed it from the latter point of view and emphasized the effect of illumination upon the emotion, and then he proceeded to the object of an ideal artificial illumination, which is not to produce almost the same lightness given by daylight, but it is to obtain a suitable light which gives special effects.

**37. *On the Influence of Ultraviolet Rays on the Eye*** (Japanese). Yoshiharu SHOJI. [J. Ill. Eng. Soc. Japan, V., 3 (1921), 201-212, with fig. and phot.]—It is a well-known fact that there would be produced certain pathological changes in the retina, crystalline lens and other tissues of eyes, when we observe a solar eclipse when we walk for a long while through the snow field, or when work in a glass-blowing.

These changes are recognized as a effect of the ultraviolet rays, which are very harmful to the eye.

It was the purpose of the author to ascertain experimentally how and at what degree these harmful rays would reach to the fundus oculi. For this investigation he employed human and animal eyes, and estimated the amount of the ultraviolet rays absorbed by the eyes. The results are as follows:—

The cornea, on the average, absorbed the rays up to 2968·86 A. E., and the humor aquens and the vitreous body also showed clearly the absorbing power.

By experiment the absorption of human crystalline lens was up to 3363 A. U., and the degree of absorption seems to be proportional to the age, and thus the rays absorbed by those of an aged person of 65 years old was up to 4000 A. U., but the retina showed no absorbing power.

The absorbing power of the crystalline lens is strongest and the those of cornea and the vitreous body follow it, while the humor aquens has the weakest absorbing power. So it can be seen from the experiment, that the absorbing power of those tissues depends on the amount of the proteins which they contain. Since the crystalline lens is affected strongly by the ultraviolet rays, the cataract would be caused according to the strength of its resistance.

The author thinks, therefore, that the new type of electric incandescent lamp (the

Canary Lamp) which radiates only slight ultraviolet ray would be a favored darkness for the retinal adaptation of the patients who are suffering from eye diseases.

**38. *Reminiscence of Illumination Progress during 1920*** (Japanese). Masaki TSUKASAKI. [J. Ill. Eng. Soc. Japan, V., 3 (1921), 125-199, with tables.]—It gives the aeroplane view of world-wide progress relating to illumination engineering during 1920 from English, American, French, German and Home literatures, dealing with the following contents: introduction, gas, incandescent illuminants, arc lamps, lamps for projection, street lighting, exterior lighting, interior lighting, fixtures, photometry, physics, physiology and psychology, legislations, illuminating engineering and conclusion.

At first the author discussed the importance of literature survey, and criticized the recent situation of science and engineering on illumination from bibliographical data. Explaining sixth sensation, poitellism, art nourathar etc., the author emphasized the modern tendency of co-ordination of the Oriental and the Occidental civilizations. It was, further, shown that Japanese art of illumination is progressing, technically and scientifically, in pace with foreign civilized countries, and that the Japanization of lighting fixture design developing with unique talent is noticeable. Among various developments in Japan, the author pointed out the following remarkable examples fluorescent incandescent lamp (canary lamp), electrical mechanism of tungsten sintering, invisible signalling with photocell, new alabaster type glassware (Jhoga glass), and several glasswares for optic and illuminating purposes. Above these, it was shown that newly developed illuminants such as lower powered gasfilled lamps, higher powered tungsten arc lamps, movie incandescent lamp, white bulb lamp, mill-type lamp, artificial daylight lamp etc. are also manufactured and are stimulating a new demand, and that off-season egg-laid under artificial illumination is now in tentative course.

Such being the case, the Japanese Illuminating Engineering Society enlarged the scale of its Constitution, and the author convinced that the Society's activity gives very hopeful promises.

**39. *Theory of Fuse*** (Japanese). Nobuyoshi KATO. [Elec. Rev. Japan, IX., 1-6 (1921), 95-101, 137-142, 219-223, 302-306, 400-405 and 485-487, with fig.]—The subject is treated under the following headings:

1. General equation for conduction of heat.
2. Its solution and discussion.
3. Determinations of fusing curve.
4. Resistance and energy during fusion.
5. Material constants.
6. Influence of length of fuse upon material constants.
7. Remarks on the determination of dimension of fuse.

Parts of the contents were presented as a discussion of the paper on "Zur Theorie der Schmelzsicherungen" by Mr. E. Tasse in Elektrotechnik und Maschinenbau at 20, November, 1910. The simplified equation for temperature distribution at any instant derived in this paper is the following.

$$\theta = \Theta \left\{ 1 - \frac{1}{\frac{1}{m} \frac{l}{L} \sinh \frac{l}{L} + \cosh \frac{l}{L}} \right\} \left\{ 1 - \left( 1 - \frac{\Theta_0}{\Theta} \frac{R_{00}}{R_0} \right) e^{-\frac{t}{\tau_0}} \right\}$$

where  $\theta$  = temperature at any point.



$\Theta$  = maximum temperature.

$m$  = certain constant depending upon material constants.

$l$  = half length of fuse wire.

$L$  = length constant.

$B$  = certain function depending upon the length of the fuse wire.

$t$  = time.

$T$  = time constant.

In this equation the relative error is discussed in practical examples of two extremities.

From this fundamental equation, the author determined the equation of fusing time at any fusing current, i. e. the equation of the fusing curve and calculated the variation of total resistance and applied voltage under constant current of the fuse wire, and finally the energy to melt it. Properties of critical current and minimum fusing current, and their relations were also discussed more completely.

**40. Abnormal Potential Rise in Transformer and its Remedy** (Japanese). TOSHISABURO TORIKAI. [Elec. Rev. Japan, IX., 9-11 (1921), 727-732, 820-825, and 894-900, with fig.]—The author describes on his new designs of bushing and transformer coils, and explains the comparatively simplified theory from which his new attempt deduced, and shows the effects of their applications and results of testing of them. The author's bushing has many rings of conductor and discs of insulator alternately piled up, having the axis of the bushing as its axis, around the ordinary bushing. The transformer coils are such that, of total number of coils, about one quarter or one third counted from the end terminal, are shunted individually with the capacity and series resistance.

The author takes an example to show the effects of his bushing, i. e., he connected his bushing in parallel with an another plain bushing which has the quite same construction and size, but differs only by without rings, and voltage are applied. In the plain bushing corona started at its foot at 40,000 volts, and at voltage over 80,000 volts, about three quarter of the surface are covered with corona streak, and, at last, at 90,000 volts are takes place, while the author's bushing has no corona yet. Then he tested it alone, disconnecting the bushing from the circuit, and observed that, till 160,000 volts, corona never started at any point.

The author describes more minutely referring to the coils and their effect to wave front, resonance, and other ordinary dangers and troubles.

**41. On the Sensibility and Efficiency of Telephone Receiver** (Japanese). HEIICHI NUKIYAMA. [Elec. Rev. Japan, IX., 5 and 6 (1921), 387-390 and 473-477, with fig.]—The importance of the exact idea of sensibility and efficiency of telephone receivers is discussed. A simple theory of ideal telephone receivers with no hysteresis and eddy current loss is given in vector diagram and symbolic form. A practical method for determining sensibility and efficiency of telephone receivers is stated, and formulae to calculate them from the tested results of motional impedance are given. The formulae are based on the theory given by Dr. A. E. Kennelly and the author, and it is proposed to call the results the optimistic sensibility and efficiency of telephone receiver. A practical example of test and calculation is also given.

**42. Oscillations of Current and Voltage when One Line of Three Phase Extra-High Tension Transmission Line is suddenly earthed.** TEIJI MICHIDA. [Elec. Rev. Japan, IX., 7 and 9 (1921), 552-555 and 703-706, with fig.]—



In this paper the author discusses the effect of neutral earthed resistance of star connected transformer upon the oscillations of current and voltage when one line of 3 phase extra-high tension transmission line is suddenly earthed.

The fundamental equations of travelling waves of current and voltage in a circuit having different electrical characteristics, can be simply denoted by

$$i = i_0 e^{-ut} e^{-s(t-\lambda)} \cos(\phi - \omega' - \gamma)$$

$$e = e_0 e^{-ut} e^{-s(t-\lambda)} \sin(\phi - \omega' - \gamma)$$

where,  $i_0, e_0 = \text{max. values of current and voltage of oscillating waves respectively}$

$$u = \text{energy dissipation coefficient of circuit} = \frac{1}{2} \left( \frac{R}{L} + \frac{G}{C} \right)$$

$$s = \text{energy transfer coefficient of circuit.}$$

$$\lambda = \text{time in second required to transmit } L \text{ em. of line}$$

$$\phi = 2\pi f' t$$

$$f' = \text{frequency of oscillation} = \frac{1}{2\pi\sqrt{LC}}$$

$$\omega' = 2\pi f' \lambda$$

$$\gamma = \text{phase angle of current and voltage at the moment of oscillation starts.}$$

The values  $i_0, e_0$  and  $\gamma$  can be represented by

$$i_0 = \frac{i'}{\cos \gamma}, \quad e_0 = \frac{e'}{\sin \gamma}$$

$$\therefore \gamma = \tan^{-1} \frac{-e'}{Z_0 i'}$$

where  $i'$  and  $e'$  are the values of current and voltage at the moment of oscillation occurs.

To determine the value of  $s$ , the following equations may be used.

$$s = u_0 - u_1 \quad \text{for 1st. part of circuit}$$

$$s = u_0 - u_2 \quad \text{,, 2nd. ,, ,,}$$

$$s = u_0 - u_3 \quad \text{,, 3rd. ,, ,,}$$

$$\dots\dots\dots$$

$$\text{where } u_0 = \frac{\sum u \lambda}{\sum \lambda} = \frac{u_1 \lambda_1 + u_2 \lambda_2 + u_3 \lambda_3 + \dots\dots\dots}{\lambda_1 + \lambda_2 + \lambda_3 + \dots\dots\dots}$$

In our case, the total current and voltage,  $i'$  and  $e'$ , during the oscillation are respectively composed of two part, 1st., the values of steady state after earthed,  $i_p \sin [\omega(t + t') - \varphi]$  and  $e_p \sin \omega(t + t')$ , 2nd., those of oscillation,  $i_0 e^{-ut} \cos(\phi - \gamma)$ ,  $e_0 e^{-ut} \sin(\phi - \gamma)$ . Therefore, at the moment of start of oscillation, they may be represented, respectively, by

$$i' = i_0 \cos \gamma + i_p \sin(\omega t' - \varphi)$$

$$e' = e_0 \sin \gamma + e_p \sin \omega t'$$

and must be known by the initial conditions of oscillation.

$$\therefore i_0 = \frac{i' - i_p \sin(\omega t' - \varphi)}{\cos \gamma}$$

$$e_0 = \frac{e' - e_p \sin \omega t'}{-\sin \gamma}$$

$$\tan \gamma = -\frac{1}{Z} \times \frac{e' - e_p \sin \omega t'}{i' - i_p \sin(\omega t' - \varphi)}$$

Substituting these values to the fundamental equations, we can calculate the oscillating waves of current and voltage, and consequently total values by adding the final steady values.

Using above equations, the author has made numerical calculations in the following case, and shown the effect of neutral earthed resistance.

length of transmission line .....	48 mile
dia. of line .....	0.524"
height of line (average) .....	25'
normal voltage at sending end .....	55,000 V.
power transmitted .....	19,000 KW.
power factor (assumed).....	1
neutral resistance inserted .....	240 ohms.

**43. On the Electrical Precipitation with Special Reference to its Extents in Japan** (Japanese). Yasujiro NIWA. [Elec. Rev. Japan, IX., 8-10 (1921), 639-643, 707-712 and 797-780, with tables.]—The outline of the history of the electrical precipitation is first described, and then the general statements of about twenty representative precipitation plants for various kinds of gases in the world are given. Its history and the present extents in Japan are next described. In 1916 the electrical precipitation plants of the capacities 10,000, 2,500 and 3,000 cub. ft. of gases per minute were experimentally installed at the copper smelters at Shisakajima, Hitachi and Ashio, respectively; the former two by their companies, and the last by the Metallurgical Research Institute of Tokyo which had purchased the Cottrell patent right in 1916 from the International Precipitation Co., U.S.A. However, the first industrial plants of this precipitation system was installed at the Asano Cement Co. of Tokyo, at the end of 1917 for the rotary kiln gas treating 70,000 cub. ft. of gas per minute. Thereafter Japan has made a rapid progress in the extent of the system. Nine precipitation plants were built at seven places; two plants, for treating cement kiln gas, one for sulphuric acid fume, and the others for smelter gas. Various numerical data on the precipitation plants in Japan are given; of which

Volume of gas treated in cub. ft. per min.	3,000.....180,000
Installation cost per 1 cub. ft. of gas treated per min.	2.4.....7.0 yen
Capacities of rectifier sets per 1 cub. ft. of gas per min.	0.33.....3.0 volt amp.
Plant area per 1,000 cub. ft. of gas per min.	60.....170 sq. ft.
Velocity of gas in the treater in ft. per sec.	2.5.....6
Power consumption per 1 cub. ft. per min.	0.12.....0.80 watt

The application of the electrical precipitation system to the steam power plants is next discussed. In the view point of the present conditions of Japan, the adoption of the system in the steam plants increases about 20 per cent. of installation cost of power plants. For 10,000 kilowatt steam turbine plant it requires the area of about one third of one acre for precipitation plant and 10 k.w. of power for it. The dusts collected will be more than 10 tons per day. There must be carefully considered to apply the electrical precipitation in steam power plant.

The author expresses his view on the further improvement of the system, in which he

points out that the decrease of installation and maintenance costs, the increase of reliability and stability of the operation, and the raising of the precipitation efficiency are the essential items to be studied. The vacuum tube rectifier instead of motor rectifier set and the precipitation treater with glass covered electrodes are insisted for the above purposes.

Finally the economical balance of the present precipitation plants in Japan is considered. Although the electrical precipitation was adopted in Japan on account of nuisance problem, the recovered substances from the collected dusts are valuable enough not only to pay the maintenance cost of the plants, but also to make some depreciation for the installation costs of them. It is stated that the electrical precipitation can be installed in Japan, independent of the nuisance problems, as the merely economical investments.

**44. Motional Impedance of Acoustically Coupled Telephone Receivers** (Japanese). Shigetaro CHIBA. [Elec. Rev. Japan, IX., 4 (1921), 306-312, with fig.]—The writer considered the motional impedance of a telephone receiver which is acoustically coupled with another receiver by means of a connecting tube. Two extreme cases are considered, and in both cases, it is assumed that the length of the connecting tube is negligibly small compared with the wave length of the telephone sound. In one case the two receivers are connected by a very short tube with a large cross section, while in the other they are connected by a longer tube with a small cross section. From the calculations given for these two cases, it may be inferred that the function of the connecting tube is equivalent to that of a transmission line with distributed capacity and inductance, if the mechanical system consisting of the connecting tube and the receivers were represented by a corresponding electrical system. Thus, when the wave length of the connecting tube is not negligibly small compared with the wave length of the sound, the resonance of the connecting tube itself may occur at several frequencies. Therefore in this case, the motional impedance curve of the receiver contains many loops. To illustrate this a numerical example of the electric circuit, having the same characteristic as the above mechanical system, is given.

**45. Theoretical Studies on the Change of Density of the Electrolyte within the Pores of the Storage Battery Plates during Discharge** (Japanese). Hiromu TANAKA. [Rep. Tokyo Imp. Ind. Lab., XVI., 1 (1921), 85-104, with diag. and fig.]—The author studied theoretically about the change of electrolyte density within the pores of lead storage battery plates during discharge, and obtained several equations representing the state of the electrolyte within the pores.

Let sulphuric acid is consumed uniformly from every part of the pores. The problem is to find the concentration at any depth of the pores, when a steady state has been reached.

Let  $g$  = concentration of the electrolyte at any depth  $l$  of the pores.

$Q_e$  = concentration of the external electrolyte of the pores.

$Q_i$  = concentration of the internal electrolyte of the pores.

$I$  = discharge current.

$S$  = total cross section of the pores.

$L$  = length of the pores.

$D$  = diffusion coefficient of sulphuric acid.

$\phi$  = amount of sulphuric acid consumed per unit electric quantity of discharge.

Then the author obtained the following equations:

$$q = \frac{4(Q_e - Q_i)}{L^2} l^2 - \frac{4(Q_e - Q_i)}{L} l + Q_e,$$

$$\text{or } q = \frac{\phi I}{2 D S L} l^2 - \frac{\phi I}{2 D S} l + Q_e.$$

From these he derived several interesting equations.

**46. On the Storage Battery Plates Using the Scaly Lead Powder Electrolytically Deposited as the Active Material** (Japanese). **Hiromu TANAKA**. [Rep. Tokyo Imp. Ind. Lab., XVI, 1 (1921), 1-83, with diag., phot. and tables.]—The author made several kinds of storage battery positive plates in which the active material is produced from scaly lead powder electrolytically deposited and measured their capacity, and researched the relation between the capacity of plates and the fineness of powder, pasting liquid, porosity of active material, etc.

Then, the author carried on durability test on the following plates and observed the effects of fineness of scaly lead powder and pasting liquids upon the durability of the plates.

Type of plates: automobile storage battery plates.

Size of plates: 12 cm. × 14 cm. × 3.5 mm.

Discharge current: 4 amps.

Charge and discharge rate: 3 hrs.

No. of discharge: 64

The over-charges and -discharges, which took place several times, accelerated the shedding of active material, and reduced the strength of plates.

No. of positive plates.	Fineness of scaly lead powder	Pasting liquid	Wt. of pos. plates before durability test in gms.	Wt. of pos. plates after durability test in gms.	Loss of PbO <sub>2</sub> in gms.*
(45)	50-160 mesh	distilled water	407.0	327.0	80.0
(46)	50-160 "	"	410.0	354.5	55.5
(47)	50-100 "	"	417.0	403.5	13.5
(48)	less than 160 "	"	452.0	468.0	(+) 16.0
(49)	50-160 "	caustic soda solution	412.0	395.0	17.0
(50)	50-160 "	"	408.0	389.5	18.5
(51)	100-160 "	"	414.0	400.5	13.5
(52)	less than 160 "	"	448.5	461.0	(+) 12.5
(53)	50-160 "	amm. sulphate solution	410.0	382.0	28.0
(54)	50-100 "	"	407.0	356.0	51.0
(55)	100-160 "	"	411.5	398.0	13.5
(56)	less than 160 "	"	438.0	447.0	(+) 9.0
(57)	50-160 "	Mg-sulphate solution	414.0	379.0	35.0
(58)	50-100 "	"	412.0	366.5	45.5
(59)	100-160 "	"	438.0	447.0	(+) 9.0
(60)	less than 160 "	"	431.0	437.0	(+) 6.0

(+) represents the increase of the weight.

According to these results, the influence of pasting liquids upon the durability is not remarkable, but that of fineness of scaly lead powder is very great, and the finest powder possesses greatest durability. Next, the author determined the durabilities of the plates, the active material of which is produced from the finest scaly lead powder, which gave the best result as above mentioned, and the plates were made by the six principal accumulator companies in Japan. The results of the test as follows:

(61), (63), (64), (65), (66), (68): Plates manufactured by the author.

(A), (B), (C), (D), (E), (F): Plates manufactured by the six companies.

Discharge current: 4 amps. (2.38 amps. per sq. dm.)

Discharge rate : 3 hrs.

No. of plates.	No. of discharges.	Wt. of plates before test in gms.	Loss of PbO <sub>2</sub> in gms.	Loss of PbO <sub>2</sub> in gms. per amp. hr.
(61)	124	475.5	42.5	0.029
(63)	"	437.0	50.0	0.034
(64)	"	460.0	52.5	0.036
(65)	"	483.0	43.0	0.029
(66)	"	467.0	44.0	0.030
(68)	"	484.5	47.0	0.032
(A)	112	432.0	84.0	0.063
(B)	"	389.0	89.0	0.066
(C)	"	428.0	111.5	0.083
(D)	64	337.5	114.5	0.149
(E)	"	384.0	67.0	0.087
(F)	"	406.0	157.0	0.204

Thus, the results of the durability test proved extremely satisfactory with the plates (61),....., (68) in comparison with any of the plates (A), ....., (F).

On the whole, positive plates of good quality can be manufactured by producing the active material from electrolytic scaly lead powder in suitable conditions.



## MINING (1—6).

1. *Korea-Manchurian Pre-Cambrian Banded Iron Ore Deposits and their Enriched Ore Bodies* (Japanese). Takeshi ICHIMURA. [J. Geol. Soc. Tokyo, XXVIII, 331-334 (1921), 152-156, 211-220, 249-247 and 295-300.]—The pre-Cambrian banded or schistose iron ore deposits are extensively developed in South Manchuria and in the Peninsula of Korea. They are magnetite-, or hematite-, or magnetite-hematite-bearing quartzose schists or quartzites, resembling Brazilian itabirite in many respects. The mode of occurrence and the associated enriched ore-bodies of various localities are fully described in the original work. Ryosuke Funahashi.

2. *Safety Door for Mine Explosions* (Japanese). Kizo OKIMOTO. [Nihon-Kōgyōkwaishi, Ser. XXXVII, 434 (1921), 211-229, with fig. and tables.]—The author has devised a safety door for the purpose of limiting the propagation of explosions in coal mines. The door is rotary type and supported by its central axis, i.e., center of oscillation, to be closed by the shock of explosion, such construction being very advantageous to resist the pressure of explosions. He recommends to build the doors within the intervals of 200 m. to stop the propagation of explosion during its initial period, the intensity of explosion being the progressive nature. Ryosuke Funahashi.

3. *The Ventilating Resistance in Japanese Coal Mines* (Japanese). Hidenosuke SANO. [Monthly Rep. C. C. M. A., Japan, XVII, 202 (1921), 289-311, with diag. and tables.]—The author discusses in detail the theory of the resistance offered by a mine to the flow of air through it, and examines the ventilating resistance of the coal mines in Japan.

The following tables give the results of examination in 138 coal mines, in 1920.

Number of mines	% of total	Equivalent orifice in sq. m.
40	29	< 1
61	44	1 - 2
37	27	> 2
Total 138	100	1.6 in average

District	Equivalent orifice in average sq. m.
Kyushu coal field	1.9
Joban coal field	1.3
Hokkaido coal field	0.8
Manchurian coal field	2.3

The author considers that the equivalent orifice of the mines at Hokkaido coal field is not large enough. In 15 mines, or 11 % of the total, the equivalent orifice coincides approximately with the "normal" orifice. Author.

4. *The Natsumé Nickel Deposits with Special Reference to the Microscopic Investigations of the Ores*. Mikio KUHARA. [Mem. Coll. Eng.

Kyoto Imperial University, 2 (1921), 101-133, with pls.]—The Natsumé mine is the sole one producing the primary nickel ore in Japan. The neighbourhood of the deposits is composed of serpentine, serpentized diorite, and Mesozoic slates and sandstones. By the intrusion of the diorite, the Mesozoic strata have been baked and silicified, and a banded metamorphic slate has been produced near the contact. Magnetite, pyrrhotite and chalcopyrite of the first generation, niccolite and rock silicates have been segregated from the diorite magma; and calcite, arsenopyrite, pyrrhotite and chalcopyrite of the second generation, quartz, pyrite, zincblende, and galena have been formed by the hydrothermal processes. The sequence of the minerals is: magnetite (oldest), pyrrhotite, chalcopyrite, niccolite, rock silicates, calcite, arsenopyrite, calcite, pyrrhotite, chalcopyrite, quartz, pyrite, zincblende, and galena. Cobaltite and chromite are here absent. The deposits occur along the margins of the serpentine, the serpentine, the serpentized diorite and the diorite-porphyrine.

The weight of nickel amounts to 40 % in the most concentrated ores, and 0.01 to 0.1 % in gangues. Ryosuke Funahashi.

5. *Magnetic Sands as the Iron Ore Resource* (Japanese). Kumahiko HASEGAWA. [Tetsu-to-Hagane, VII., 3 (1921), 189-200, with fig.]

6. *On the Combustion of the Pulverized Coal Experienced in the Osaka Arsenal* (Japanese). Masakuni SUGIMOTO. [Nihon-Kôgyôkwaishi, XXXVII., 438 (1921) 493-512, with diag. and pl.]

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## METALLURGY (1—19).

1. *The Basic Lined Converter at the Kosaka Smelter* (Japanese). Kenzo IKEDA. [Nihon-Kôgyôkwaishi, XXXVII, 431 (1921), 22-37, with pl.]—The first successful attempt of the basic process was made by the author at the Kosaka Smelter on July 14th in this year, which has been proved to be a metallurgical and financial success through the succeeding operations. After but a little change in construction, the old 7 ft. dia. by 10 ft. 6 in. acid lined shells (barrel type) have been relined with Japanese magnesite brick of the standard size, and the proper backing of magnesia fines and grains, using water solution of the crystal Nigari (brine) as the binding material.

Generally speaking, each vessel handles 55,000 lb. of matte, 40% Cu grade, per day, employing acidic copper ore grains (nearly 15% to the matte charged), yielding 22,000 lbs. of anode copper in 4 blows, requiring about 3 hr. in net blowing per operation. The slag contains only 16%  $\text{SiO}_2$  and is highly magnetic. The slag fall against to the matte is only 50 per cent., keeping some 3% Cu in it, so that the recovery of copper is exceedingly superior to the acid working. The life of the basic lining at Kosaka seems to be practically permanent compared to the acid lining, with a much more promising future than we expected before. The author dares to say this process is advisable to be adopted with excellent advantage over the acid converting, even in Japanese plants where comparatively small amount of matte is treated.

Author.

2. *The Grain Growth of Low Carbon Steel and its Relation to Physical Properties*. Ihei SUGIMURA. [Tetsu-to-Hagane, VII, 1 (1921), 33-39.]—The author took a commercial mild steel with round shape containing carbon 0.11%, and subjected it to various heat treatments, at temperatures from 700°C. up to 1410°C. The average size of ferrite grains has been measured, and various physical tests, such as hardness test, strength test and magnetic test, were carefully conducted.

K. T.

3. *X-Ray Examination of Inner Structure of Strained Metals. I. Chiefly on Copper Wires*. Akimasa ONO. [Mem. Coll. Eng. Kyushu Imperial University, 2 (1921), 1-241.]—X-ray interference examination was performed on strained metals, viz., copper wires (in the drawn and annealed state), low carbon steel bars (in the pulled and annealed state), etc., by applying the white ray issuing from a Coolidge tube of tungsten anticathode. The results show that the crystal lattices of metals form fibrous structure in the pulled or drawn state, and that the structural rearrangement proceeds as the degree of strain increases.

Particularly in the case of copper, of which the atoms are known to be arranged in a face-centred cubic lattice, the inclinations of several simple planes in the lattice and the relative intensities of rays are calculated, and it is shown that the trigonal axis of the lattice is in the longitudinal direction of wire, if the degree of drawing is sufficient.

A brief reference is added to the existing hypotheses for the structural change of the strained metal, and it is suggested that the change in the lattice arrangement of crystals affords a natural explanation of the change of properties observed in metals that have been subjected to strain.

Author.

4. *On the Salamander of Iron Blast Furnace at Yawata* (Japanese).

Kumahiko HASEGAWA. [*Tetsu-to-Hagane*, VII, 4 (1921), 935-943, with fig.]—The chemical compositions of the salamander in two blast furnaces of the Yawata Steel Works have been fully studied. In both cases the author found some beautiful copper red crystals with a metallic lustre which have been proved to have  $\text{Ti}_3\text{CN}_3$  as their chemical formula.

Into one of the furnace a small amount of titaniferous iron ore from Korea, containing titanium 11.58 %, was charged. The titanium content of the whole charges being only from 0.22 to 0.44 %, the distribution of that element in the furnace products has been calculated. About 7 % and 93 % of the whole content of titanium went to pig iron and salamander respectively, while none of it could be traced in the slag produced.

K. T.

5. *On the Arsenic in Japanese Iron-Ores, Pig Iron and Steels* (Japanese). Binjiro TAZAWA. [*Tetsu-to-Hagane*, VII, 11 (1921), 1065-1085, with fig. and tables.]—After various methods for arsenic determination had been carefully checked, the author chose for his investigation a volumetric method using standard iodine solution.

The arsenic content of oriental iron ores varies in general from 0.07 to 0.15 %, while those used in the Yawata Steel Works contain arsenic from 0.007 to 0.03 %. On the other hand pig irons and steels from that works, contain arsenic from 0.0071 to 0.017 % and from 0.0012 to 0.0028 %, respectively.

The amount of this element in steel seems to have no mutual relation to those of carbon and other elements in it.

K. T.

6. *On Copper Steel* (Japanese). Rikuzo JÖYA. [*Tetsu-to-Hagane*, VII, 2 (1921), 85-103, with fig. and tables.]

7. *The Characteristic Figure and Forging Structure on the Sharpened Surface of Japanese Swords* (Japanese). Kuniichi TAWARA. [*Tetsu-to-Hagane*, VII, 3 (1921), 201-204, with fig.]

8. *The Measurement of the Shape and Size of Japanese Swords* (Japanese). Heikichi AOYAMA. [*Tetsu-to-Hagane*, VII, 3 (1921), 20-211, with fig. and tables.]

9. *On the Grain of Alloy-Castings* (Japanese). Yoshizo TAGUCHI. [*Tetsu-to-Hagane*, VII, 4 (1921), 287-350, with fig.]

10. *On the Warship and its Steel-Material* (Japanese). Yuzuru HIRAGA. [*Tetsu-to-Hagane*, VII, 5 (1921), 407-437, with fig. and tables.]

11. *On the Equilibrium Diagram of the Quaternary Alloy System* (Japanese). Hideo NISHIMURA. [*The Suiryô-Kwaishi*, III, 8 (1921), 932-948, with pl. and tables.]

12. *On the Gas-Producer in Steel Manufacture* (Japanese). Matsujiro HAMAZUMI. [*The Suiryô-Kwaishi*, III, 8 (1921), 968-991.]

13. *On the Kuroda's By-Product Coke Oven* (Japanese). Taizo KURODA and Hiroshi ONO. [*The Seitetsu-Kenkyu-Kwai Kiji*, 63 (1921), 133-139, with pl.]

14. *On the Electro-Metallurgy of Ferro-Manganese* (Japanese). Takijiro FUJIKI. [Rep. Research Inst. Yawata Steel Works, 1 (1921), 15-66, with tables.]
15. *On the Determination of Electric Conductivity, Specific Heat, Density, and Expansion-Coefficient of Various Refractories and Rocks* (Japanese). Yoshiaki TADOKORO. [Rep. Research Inst. Yawata Steel Works, 1 (1921), 69-108, with diag., fig. and tables.]
16. *On the Results of Examination of the Damaged Rails* (Japanese). Koshiro TSUKAMOTO. [Tetsu-to-Hagane, VII., 8 (1921), 819-824, with tables.]
17. *On the Gas Producer* (Japanese). Hajime TANAKA. [Tetsu-to-Hagane, VII., 10 (1921), 985-994, with tables.]
18. *On the Electric Smelting of Low-Phosphorous Pig Iron* (Japanese). Torao KUNO and Shiro INAGAWA. [Tetsu-to-Hagane, VII., 10 (1921), 994-1002.]
19. *On the Iron Wire for Electrical Engineering* (Japanese). Suketsugu KIMURA. [Tetsu-to-Hagane, VII., 10 (1921), 1002-1030, with fig., pl. and tables.]
20. *Effects of Phosphorous and Silicon on the Physical Properties of Cast Iron* (Japanese). Shonosuke IGUCHI. [The Suiyô-Kwaishi, III., 9 (1921), 1079-1095, with diag., phot. and tables.]
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## CIVIL ENGINEERING (1-61).

1. *Reinforced Brick Masonry* (Japanese). **Seishi KANAMORI**. [J. Civ. Eng. Soc., VIII, 1 (1922), 41-76, with fig.]-The weakness of ordinary brick work against tension needs no explanation. To obviate tensile stress in a structure subjected to compression and bending combined entails the use of a large amount of material. Reinforced brick work provides as much tensile strength as may be required without lowering its resistance to compression, nor impairing the good appearance inherent in good brick work. Unlike reinforced concrete it does not require any mould or form in construction. It is as simple in execution as ordinary brick masonry. One distinguishing feature of reinforced brick work is the use of metallic rods, and bricks of special forms to allow of the rods being placed in position. Investigations have shown that it is essential for the holes prepared in the bricks to be twice the cross sectional area of the rods, and for the latter to be covered with mortar to a thickness of more than  $\frac{5}{8}$  of an inch.

2. *Travel of Sea-Water Spray with Snow in Storms* (Japanese). **Tadaichi CHŌ**. [Bull. Imp. Gov. Rwy. Research Bureau, X, 1 and 3 (1922), 61-63 and 412-414, with fig.]-The travel inland of sea-water mixed with snow has an important bearing on the durability of metallic structures. The following observations were made along the Ōwū Railway, at points between Nojiro and Ōdate, first in Nov. 1921, after a storm from the north-west with winds blowing 8 m. per sec., and then again in Jan. 1922, when the N.W. wind attained 40 m. per sec.

Dist. from the Shore in miles.	Amt. of Salt Content Pts. in 100,000.	
0	9.62	—
2	4.73-10.03	2.3-12.0
4	8.48	1.6-7.7
9	8.97	—
12	5.38	—
19	4.24	2.1-6.8
24	3.91	1.6-2.1
31	1.79	1.4-3.4

It was found that obstructions in the path of the snow, however small, as well as the configuration of the ground, exercise considerable influence on the amount of salt content.

3. *On Seismic Damage and the Intensity of Earthquake Motion* (Japanese). **Fusakichi ŌMORI**. [Bull. Imp. Gov. Rwy. Research Bureau, X, 2 (1922) 153-178, with maps.]-A brief statement of the amount of seismic damage and the stability against earthquake motion of different kinds of buildings, is followed by a summary of the damage corresponding to the different values of the seismic intensity, namely, the maximum acceleration of the earthquake motion. The principal earthquake zones in Japan are considered in some detail, with reference to the intensity of the seismic motion likely to occur in future in different parts of the Empire.

Author.

4. *Tunnel Construction* (Japanese). **Sakuro TANABE**. [I. Ed. 1 Vol. (1922)]

Tokyo, 2+2+196, with fig.]—The book is a practical treatise on tunnel construction. The outstanding feature of the work is a chapter on subaqueous tunnelling. Reference is made to the proposed tunnel under the Shimonoseki Straits, concerning which an abstract of the report on the preliminary work was given in the preceding issue.

**5. Formula for the Maximum Flood Discharges of Rivers in Chosen** (Japanese). **Asajiro KAJIYAMA**. [J. Civ. Eng. Soc., VIII., 4 (1922), 831-860, with fig. and tables.]—The subject of the paper is one based on the records of flood discharges in the river Kanko, Kiuko, Yeisanko, Rakutoko, Saineiko, Josenko, Ryukoko and Seichikoku. Some of these flood discharges were computed with Kutter's formula from measurements made on the slopes of the flood water, and some from the discharge curve of the river basin in question. Modifying the existing formulas for max. discharge to suit the results of these observations, the following formula is obtained:  $Q = C.A^{n-m} \log A$  in which  $Q$ =max. flood discharge in cub. *shaku* per sec.,  $A$ =area of the river basin in sq. *ri*,  $C, n, m$ =constants which for the preceding cases are:  $n=0.87$ ,  $m=0.04$ ,  $C=5,000-8,000$ .  $C$  appears to vary with the amount of rainfall, the configuration and nature of the basin. It may be generally expressed by  $C = F(310 + \gamma)\left(4 + \frac{A}{L}\right)$  in which  $\gamma$ =the max. daily rainfall in the basin;  $L$ =the length of the basin in *ri*;  $F$ =coefficient of the run-off, varying from 2.19 to 2.74 according to the amount of run-off.

**6. On the Calculation of Stresses in a Continuous Beam of Reinforced Concrete** (Japanese) **Yosei YAMADA**. [J. Civ. Eng. Soc., VIII., 5 (1922), 977-1093, with fig. and diag.]—The treatment of a continuous beam of reinforced concrete under the assumption of uniform flexural rigidity ( $EI$ ), as found in the Government regulations, is not rational for the following reasons: (1) The amount of reinforcement near the supports differs considerably from that of an intermediate portion of the beam. (2) The common use of T-section in continuous beams. An analytical proof is given by working out various cases of continuous girders under different modes of loading.

**7. Formula for the Strength of Plate Springs** (Japanese). **Yutaka TANAHA**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 7 (1922), 1339-1357, with fig.]—A plate spring consists of plates with different curvatures, being in contact with each other only at the ends when unloaded, and coming in full contact only when fully loaded. Equations for the following are deduced: (1) Bending moment at any point in the plate series. (2) Force acting at the ends of plates in the series. (3) Deformation of the longest plate, the latter being given a uniform section. (4) Deformation of an intermediate plate. By using these equations a formula for the coefficient of friction between the plates is worked out with several numerical examples.

**8. The Allowable Limit for the Wear of Wheel Flanges** (Japanese). **Transport. Dept. of Imp. Gov. Rwy.** [Bull. Imp. Gov. Rwy. Research Bureau, X., 7 (1922), 1358-1370, with fig.]—Derailments of cars are often caused by

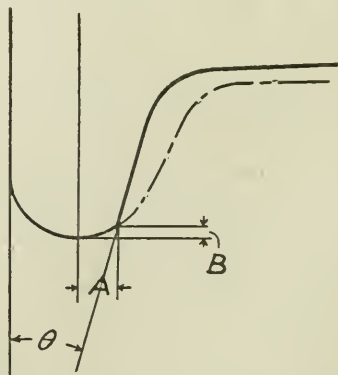


Fig. 1.

excessive wearing of the wheel flanges. To prevent them, it is necessary to fix the allowable limit for such wear. Careful measurements made of the cross sections of 163 different wheels which derailed have shown that about 70% of the cases of derailments might have been avoided, and proper precaution been taken to keep the increase of the dimensions of  $A$ ,  $B$  and  $\theta$  in the adjoining figure, within proper limits.

The latter have been found to be as follows: (1) The measurement of  $B$  should not exceed 1.5 mm. (2) The measurement of  $B$  should be kept under 3 mm. and  $\theta$  under 17 degrees.

**9. Formulas for Strength of Tapered Posts** (Japanese). Suejirō TAKAHASHI. [Bull. Imp. Gov. Rwy. Research Bureau, X., 10 (1922), 1903-1920, with fig.]—Two cases of loading are considered: (1) When the horizontal force is applied at the apex of the post. (2) When the horizontal force is applied either at the top of a truncated post or at an intermediate point of one fully tapered. Using Morley's deductions given in Engineering (London) Vol. CV, the author derives a formula for each case and compares it with the results of tests made on Bates Patent Expanded Steel Posts.

**10. On the Strength of Reinforced Concrete Columns** (Japanese). Juichirō NAKAHARA. [Bull. Imp. Gov. Rwy. Research Bureau, X., 11 (1922), 2192-2226, with fig. and phot.]—The paper gives the details of the test made on the Matsuda Patent Reinforced Columns, which are formed of premoulded hollow blocks set in mortar. Each block has four main reinforcements bound together with spiral hoops. Several sizes of blocks are used so as to form a suitable taper from the top to the bottom. In the test, the bending force was applied in two different ways viz.: In the plane of the two opposite main reinforcements, in the plane making 45-degrees with the latter. In each case a horizontal load was applied at the top of the column. The tests have shown: (1) That the strength of such columns calculated with column formulæ agrees fairly well with the actual one. (2) The appearance of hair cracks throughout the length of the column signals the approach of failure and may be considered as its ultimate resistance.

**11. Improved Flushing Siphon for Sewers** (Japanese). Kazuyuki HIRONAKA. [Kogaku, IX., 7 (1922), 412-415, with fig.]—The chief defects of an ordinary siphon are: (1) Excessive delicacy in starting siphon action. (2) Nicety of construction. (3) Leakage of water tank. (4) Stoppage of air valve by dust. The effective improvements consist in: (1) Making the mouth of the siphon tube funnel-shaped, which facilitates the starting of siphon action. (2) Making the sectional form of the siphon tube at the bottom a flat ellipse, which assists the escape of large bubbles from the siphon tube. (3) Providing a small hole (about 15 mm. in dia.) near the bottom of the bell for introducing air into the bell to stop the siphon action. (4) Doing away with subsiphon and air valve. (5) Simplifying the details of construction as much as possible.

K. Yamazaki.

**12. On the Prevention of Oxidation in Steel Girders** (Japanese). Shūichi NAGAYA. [Bull. Imp. Gov. Rwy. Research Bureau, IX., 12 (1921), 971-976.]

**13. On the Durability of Smoked Sleepers** (Japanese). [Bull. Imp. Gov. Rwy. Research Bureau, IX., 12 (1921), 977-979, with a table.]

**14. Construction of the Madrid Underground Railway** (Japanese). Yoshiaki HATTA. [J. Civ. Eng. Soc., VIII., 2 (1922), 247-279, with fig. and pict.]



15. *Well Sinking by the Use of Hydraulic Ejectors* (Japanese). Jukichi **FUJINE**. [J. Civ. Eng. Soc., VIII, 2 (1922), 281-305, with fig., pict. and tables.]
16. *Prussian Water Laws and the Revision of our River Laws* (Japanese). Kyosaburo **SASAKAWA**. [J. Civ. Eng. Soc., VIII, 2 (1922), 307-388.]
17. *Evolution of Railroad Building and Bridgework in America*. J. **A.L. WADDEL**. [J. Civ. Eng. Soc., VIII, 1 (1922), 9-40.]
18. *Report on the Competitive Designs for the Yellow River Bridge* (Japanese). Takuichi **OMURA**. [J. Civ. Eng. Soc., VIII, 1 (1922), 77-94, with fig.]
19. *On Earth Dams* (Japanese). Shō **MIZUTANI**. [J. Civ. Eng. Soc., VIII, 1 (1922), 95-145, with fig.]
20. *Snow as an Impediment to Railway Traffic* (Japanese). Yūkuma **TŌTAKE**. [J. Imp. Rwy. Assoc., XXIII, 3 (1922), 187-189, with diag.]
21. *Test of the Strength of Joints between Old and New Concrete* (Japanese). Shō **MIZUTANI**. [Kogaku, IX., 1 (1922), 19-23, with fig. and diag.]
22. *On the Use of Mucking Machines in Tunnel Construction* (Japanese). Yasukichi **OKASAKI**. [Kogaku, IX., 1 (1922), 28-37, with fig. and diag.]
23. *Resistance of Columnar Structures against Earthquakes* (Japanese). Rempei Sato. [Kogaku, IX., 2 (1922), 65-77, with fig.]
24. *Graphical Dimensioning of Reinforced Concrete Beams* (Japanese). Hiroo **KIMURA**. [Kogaku, IX., 2 (1922), 82-84, with diag.]
25. *Manual versus Mechanical in Tunnel Excavation* (Japanese). Tsune **NISHIHATA**. [Kogaku, IX., 2 (1922), 89-98.]
26. *Calculation of Anchorage for Bends of Penstock* (Japanese). Tamazo **SHINOSE**. [Kogaku, IX., 2 (1922), 103-107, with fig.]
27. *Physical Tests of Structural Stones* (Japanese). Goro **HODOJIMA**. [Kogaku, IX., 2 (1922), 108-117, with fig. and tables.]
28. *Calculation of Stresses in Suspension Bridges* (Japanese). Ichihei **KANAYEDA**. [Kogaku, IX., 4 (1922), 179-195, with fig.]
29. *Principles of Design of a Freight Station in a Large City* (Japanese). Sukehiko **GOTO**. [Civil and Arch., I, 1 (1922), 6-7, with phot.]
30. *A Method of Plate Girder Erection by Launching* (Japanese). Keiichi **KUBOTA**, [Civil and Arch., I, 1 (1922), 10-11. with fig. and phot.]
31. *Deflection of a Simple Girder with Varying Moment of Inertia* (Japanese). Yōnosuke **TANII**. [Civil and Arch., I, 1 (1922), 12-13, with fig.]



32. *Report on the Investigation into the Nature of Gases from the Heading of the Tanna Tunnel* (Japanese). **Kimpei YOSHIDA**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 5 (1922), 821-832, with tables.]

33. *On Waterways between the Great Lake Districts of North America and the Atlantic Ocean* (Japanese). **Masaji SUZUKI**. [J. Civ. Eng. Soc., VIII, 3 (1922), 455-478, with fig. and pict.]

34. *The Port of Shanghai* (Japanese). **Isami HIROI**. [J. Civ. Eng. Soc., VIII, 3 (1922), 541-547, with fig.]

35. *Reconstruction in the Devastated Districts in France* (Japanese). **Nagaho MONONOBE**. [J. Civ. Eng. Soc., VIII, 3 (1922), 549-570, with fig.]

36. *On the Calculation and Design of Reinforced Concrete Roof-slabs on Road Culverts* (Japanese). **Ichiro TAKEUCHI**. [J. Civ. Eng. Soc., VIII, 3 (1922), 571-616, with fig. and tables.]

37. *On Red Mites; their Prevention and Destruction* (Japanese). **Rinya KAWAMURA**. [J. Civ. Eng. Soc., VIII, 3 (1922), 479-540, with fig. and pict.]

38. *Tests of Various Water Purifiers* (Japanese). **Takuro SUZUKI**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 8 (1922), 1639-1660, with tables.]

39. *Philadelphia Elevated Railway* (Japanese). **Junzō FURUKAWA** and **Takesada KURODA**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 7 (1922), 1285-1319, with fig. and pict.]

40. *Rusting of Metallic Structures on Akita-Hirosaki Line* (Japanese). **Tadaichi CHŌ**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 7 (1922), 1321-1337, with fig.]

41. *On Illumination of Railway Stations* (Japanese). **Nagashi ONODERA** and **Ichirō YAMAMOTO**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 8 (1922), 1571-1611, with fig. and pict.]

42. *Carbon Dioxide in Tanna and Izumigoe Tunnels* (Japanese). **Kimpei YOSHIDA**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 8 (1922), 1613-1616 with tables.]

43. *Experiments with Vacuum Sand Box* (Japanese). **Kenjiro KUWABARA**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 8 (1922), 1626-1638, with diag. and tables.]

44. *A Deep Artesian Well in Omiya Railway Yard* (Japanese). **Ryokei ONO**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 11 (1922), 2173-2191, with fig.]

45. *On Air Brakes of Electric Railway Cars* (Japanese). **Kenjiro KUWABARA**. [Bull. Imp. Gov. Rwy. Research Bureau, X., 11 (1922), 2271-2283, with diag. and tables.]

46. *On Illumination of Railway Yards* (Japanese). **Nagashi ONODERA**

and Ichirō YAMAMOTO. [Bull. Imp. Gov. Rwy. Research Bureau, X., 10 (1922), 1933-1971, with diag. and pict.]

47. *The Tanna Tunnel* (Japanese). Isami AOKI and Kameji YAMADA. [J. Civ. Eng. Soc., VIII, 4 (1922), 705-734, with fig.]

48. *The Customs Piers and Equipment at Kobe* (Japanese). Kiichiro MORIGAKI. [J. Civ. Eng. Soc., VIII, 4 (1922), 735-802, with fig. and pict.]

49. *Torrent Works in the Nikkawa* (Japanese). Makoto KABA. [J. Civ. Eng. Soc., VIII, 5 (1922), 961-975, with fig.]

50. *Underground Railways for Tokyo* (Japanese). Yoshiaki HATTA. [J. Imp. Rwy. Assoc., XXIII, 4 (1922), 239-257.]

51. *Freight Delivery in Tokyo* (Japanese). Shincho SAITO. [J. Imp. Rwy. Assoc., XXIII, 6 (1922), 409-418.]

52. *Rails used on Railways of Different European Countries* (Japanese). Kuniichi TAWARA. [J. Imp. Rwy. Assoc., XXIII, 6 (1922), 379-396.]

53. *Electric Tramways in Tokyo* (Japanese). Hampei NAGAO. [J. Imp. Rwy. Assoc., XXIII, 5 (1922), 285-294, with tables.]

54. *Modern City Planning in Chosen, as exemplified by that of Taikyū* (Japanese). Masayoshi UYENO. [Kogaku, IX., 7 (1922), 416-431, with fig., diag. and tables.]

55. *On Pavements* (Japanese). Tokikazu SAKATA. [Kogaku, IX., 7 (1922), 375-382.]

56. *Disposal of Waste Water from Factories* (Japanese). Tokikazu SAKATA. [Kogaku, IX., 9 (1922), 523-524.]

57. *On Design of Spillways* (Japanese). Tei SAKAE. [Kogaku, IX., 9 (1922), 560-566, with fig.]

58. *Dams for Arrestation of Sand* (Japanese). Makoto KABA. [Kogaku, IX., 9 (1922), 535-539, with fig.]

59. *Asphalt and its Useful Properties* (Japanese). Ryosei ICHIKAWA. [Kogaku, IX., 9 (1922), 677-678.]

60. *New Method of Calculating Stresses in Reinforced Concrete Girders* (Japanese). Shutaro HANABUSA. [Civil and Arch., I., 3, 4 and 6 (1922), 10-11, 7 and 9-10, with fig.]

61. *Grade for Hump Yard* (Japanese). Sueichi TAKENOUCHI. [Civil and Arch., I., 2 (1922), 7-8, with fig.]

## MECHANICAL ENGINEERING (1-16).

1. *Some Researches on the Ternary Alloys Cu-Al-Ni* (Especially as Materials Exposed to Moderately High Temperatures as Turbine Blades, Valves, etc.) (Japanese). **Ityo IYATAKA**. [J. Soc. Mech. Eng. Tokyo, XXV., 72 (1922), 1-27, with fig. and pl.]-The author studied this ternary system principally on copper corner from the metallographic point of view and discovered an alloy which is especially suitable as material exposed to moderately high temperatures. The hardness, strength, elongation, touchness, etc. of this alloy, and the changes of these properties with the increase in temperature were carefully investigated. Transformation at about  $700^{\circ}$  was examined by means of electric resistance measurement, thermal and microscopic analyses. This alloy absolutely resists oxidation at  $800^{\circ}$ , even in pure oxygen.

2. *On the Strength of Chain Links*. **Toshio NISHIHARA**. [J. Soc. Mech. Eng. Tokyo, XXV., 72 (1922), 29-63, with fig.]-The fundamental equations for a curved beam are applied to the oval chain links commonly in use. The stress distributions in the short, long and stud links are calculated for the different kinds according to the loading conditions, and the effects of the studs in the stud links are computed. The maximum stresses in elliptical links are also found partly by means of the graphical method. These investigations show that the maximum stresses in the open links appear at the inner sides of the major axes ends. Those in the stud links also take place at the same points except in the case of the heaviest loading, but they are in every case only about  $2/3$  of those in the open links. Assuming the elastic limit of the material the suitable allowable stresses are recommended and they are compared with those given by different authorities.

3. *On the Inspection of a Screw Gauge or a Screw Tap* (Japanese). **Tsuruzo MATSUMURA**. [J. Soc. Mech. Eng. Tokyo, XXV., 72 (1922), 65-72, with fig.]-In the inspection of a screw gauge or a screw tap by a projectograph the author points out the irrationality of comparing the projected image from a screw, whose axis is placed at right angles to the light beam, with the screw contour. He has found the equation of the image boundary, that is the envelope of helices passing through a point on the contour and ascertained, as an example, that in the image of 1 inch Seller's screw, magnified 50 times, the width of thread is about 4 mm. greater than the width between threads at half the height of thread, and the thread angle of  $60^{\circ}$  appears to be about  $60^{\circ} 9'$ .

He suggests placing the axis of the screw at such an inclination that a tangent to helix coincides with the light beam, and comparing the image thus obtained with the normal section of thread. He has obtained the equation of the image boundary and points out that the error still remaining is very small, practically nothing. Finally he gives a simple graphical method of correcting the contour drawing to the normal section drawing for the object of comparison.

4. *On a Gear Tooth for Power Transmission* (Japanese). **Kunizo AKUTSU**. [J. Soc. Mech. Eng. Tokyo, XXV., 73 (1922), 71-86, with fig.]-A new profile of gear teeth is described. Let  $a$  and  $b$  be the centres of a pair of toothed wheels and  $A$  and  $B$  their respective pitch circles touching each other at  $C$ . Draw a straight line  $CD$  making an angle  $\alpha$  with the common tangent. Draw an arc of circle  $E$  with radius  $r$  touch-

ing the straight line  $CD$  at  $C$ , and when the peripheral velocity of  $R$  is made equal to that of  $A$  or  $B$  multiplied by  $(AP \sin \theta)/(AC \cos \phi)$ , in which  $P$  is a point on the arc  $R$  and  $\theta = \angle APB$ ,  $\phi = \angle DCP$ , the locus of the point  $P$  gives the profile of the teeth satisfying the condition of constant velocity ratio. The specific slip of these teeth is shown to be much less than that of involute teeth. A practical method of drawing an approximate profile of tooth is also given.

**5. Approximate Equation for an Eccentrically Loaded Column.** Ariya INOKUTY. [J. Soc. Mech. Eng. Tokyo, XXV., 73 (1922), 87-90.]—The author gives an approximate equation, for a long column of uniform section with an eccentric load acting parallel to the axis of the column, in the following algebraic form:—

$$\left(\frac{f_c}{p} - 1\right) \left(1 - \frac{\pi^2}{8} \cdot \frac{p}{p_0}\right) = \frac{cy}{k^2},$$

in which  $f_c$  is the greatest bending stress occurring at the compression edge of the section farthest from the line of load,  $p$  the intensity of the load per unit area of the section,  $c$  the amount of eccentricity of the load,  $y$  the distance of the compression edge from the centroid of the section,  $k$  the radius of gyration of the section, and  $p_0$  that value of  $p$  which Euler's formula would require for the column of length  $l$ , were the load exactly axial, that is,  $p_0 = (1 \text{ or } 4 \text{ or } 2) \pi^2 E k^2 / l^2$ , according as the two ends are hinged, or the two ends are fixed, or one end is hinged and the other fixed.

S. T.

**6. Laws of Failure of Solid Bodies due to Stress.** Chidō SUNADANI. [J. Soc. Mech. Eng. Tokyo, XXV., 74 (1922), 1-38, with fig.]—Observing the facts that a solid body starts to fail either by sliding separation or by tensile separation, and that the plane of separation deviates in a sliding failure a certain angle from the maximum shear plane, and in a tensile one the same angle from the plane of the greatest principal stress, the author establishes two hypotheses, (a) that shearing strength decreases proportionally to the normal component of stress on the plane of failure, tensile stress being considered to be positive, and (b) that tensile strength decreases proportionally to the tangential component of stress. From these hypotheses, he derives mathematically the following laws:—

In an isotropic body, (1) there occurs a sliding or a tensile failure according as

$$\frac{1}{2 \cos \phi} \left\{ T_1 - T_3 + (T_1 + T_3) \sin \phi \right\} > R_{s0} \text{ or } \frac{1}{2 \cos \phi} \left\{ T_1 - T_3 + (T_1 + T_3) \cos \phi \right\} > R_{t0},$$

where  $T_1$  and  $T_3$  are the greatest and the least principal stresses,  $\phi$  a constant, and  $R_{s0}$  and  $R_{t0}$  the shearing and the tensile strengths in the cases when the normal and the tangential components of stress, respectively, are nothing, and (2) the normal of the plane of failure lies in the plane of the middle principal stress and makes an angle of  $\left(\frac{\pi}{4} - \frac{\phi}{2}\right)$

or  $\frac{\phi}{2}$  with the direction of the greatest principal stress, according as it is a sliding or a tensile failure. In this paper, the experimental results of some other authors and of the author of this paper prove the above hypotheses and laws to be true in both elastic and ultimate failures and show that  $\phi$  is a constant,  $20^\circ$ , in both sliding and tensile failures and in all kinds of material.

Author.

**7. Notes on the Draught Tube of a Water Turbine.** Otagoro MIYAGI. [J. Soc. Mech. Eng. Tokyo, XXV., 74 (1922), 39-50, with fig.]—The equation of the meridian section expressed by cylindrical co-ordinates of an ideal draught tubes of circular section



satisfying the condition of irrotational flow in it, conducting water vertically downwards to the tail race, changing its direction to horizontal on its bed, will be :

$$r^2 z = m,$$

$m$  being a constant depending on the quantity of discharge and the rate of variation of component velocities.

Assuming a draught tube to be of this form the theoretically best height of the lowest edge of the expanded mouth of the draught tube above the sole plate, which is denoted by  $z_0$ , will be given by solving  $x$  from :

$$x^4 - \frac{\sqrt{m}}{3f_1} x^3 + \frac{m}{2} x^2 + \frac{m^{\frac{3}{2}}}{3f_1} x + \frac{(f_1 + f_2)m^2}{16f_1} = 0,$$

where  $f_1$  and  $f_2$  are the kinematic coefficients of friction in the draught tube and on the sole plate respectively, and then applying :

$$z_0 = x^{\frac{2}{3}}.$$

Approximate method to determine  $x$  is as follows :—

First calculate  $x'$  from :

$$x' = \sqrt{\frac{3m}{8}}$$

and determine  $\delta$  from :

$$\delta = \frac{x'^4 + \frac{m}{2} x'^2 + \frac{m^{\frac{3}{2}}}{8f_1} x' + \frac{(f_1 + f_2)m^2}{16f_1} - \frac{\sqrt{m}}{3f_1} x'^3}{\frac{\sqrt{m}}{f_1} x'^2 - \left[ 4x'^3 + mx' + \frac{m^{\frac{3}{2}}}{8f_1} \right]},$$

and then get the sum of  $x'$  and  $\delta$  which gives  $x$ , thus :

$$x = x' + \delta.$$

Author.

### 8. Further Report on Repeated Impact Tests. Tsuruzo MATSUMURA

[J. Soc. Mech. Eng. Tokyo, XXV., 74 (1922), 73-86, with fig., phot. and tables.]—The subject of the paper is the report of results of the author's repeated impacts tests. As the summary he states :

1. The remaining pieces of the same flat bars as in the previous repeated impact test were utilized for further tests to find the effect of depth of notch on the result and it was ascertained that, with an increasing depth of notch, the blow number falls at a greater rate as a steel contains more carbon.

2. Comparative tests on steel bars of possibly uniform composition but with different amounts of phosphorus were performed and it was found that in the mild steel containing about 0.3% carbon the effect of phosphorus on the resistance to repeated impacts is not appreciable, so far as its content is less than about 0.07% and only when this limit is exceeded is the resistance spoiled.

3. A comparison of the blow number with the Upton-Lewis' toughness number for the steel grades containing from 0.1 to 0.71% of carbon was made. Both the blow number as well as the toughness number show similarly the maximum value for about the same carbon content, but the blow number falls at a faster rate than the toughness number as the amount of carbon increases.

4. Test pieces cut from a mild steel bar were tested in the repeated impact machine,



each under a different impact energy and the result is formulized to

$$n = \frac{30,800}{e^{1.65}},$$

$n$  being the blow number and  $e$  the impact energy in cm-kg.

Author.

**9. On the Balancing of Turbine Rotors.** Kyoji SUYEHIO. [J. Soc. Mech. Eng. Tokyo, XXV., 75 (1922), 1-10, with fig.]—To eliminate guess work which is, without a single exception, associated with all methods of rotor balancing, the author devised a new method and an apparatus for it. In this method a rotor to be balanced is held at each end of the shaft by a special bearing made for the present purpose, which is in turn supported by a set of springs. The bearings are so constructed that the rotor may vibrate with any one of them as centre and the other as a free end.

A pair of measuring wheels composed of idle and fixed wheels are temporarily fitted to each end of the rotor shaft. The idle wheel, which by a proper arrangement is made to revolve with a little speed difference, carries a small weight to produce an unbalanced force of known magnitude. As the relative phase of this unbalanced force and the rotor changes uniformly, the intensity of the vibration of the rotor varies accordingly. The phase of the angular position of the idle wheel relative to the fixed wheel is observed directly by means of the device used in the author's torsionmeter and is recorded along with the vibration of the rotor.

From such a record the resultant unbalanced moments of the rotor about each bearing can be found, and therefrom the required unbalanced force and couple are found with an analysis.

Author.

**10. Transformation of the Section of a Beam for Greatest Resistance.**

Ariya INOKUTY. [J. Soc. Mech. Eng. Tokyo, XXV., 75 (1922), 11-24, with fig.]—When a beam is under the action of a direct axial tension or thrust, as well as of a transverse bending load, or when the material of a beam has unequal resistance to tension and compression, it is usual in practice to design the section of the beam unsymmetrical with respect to the neutral axis of the section. The author gives a method of deriving the best figure from the original symmetrical section, which may be called a linear transformation of the section, the depth and area of the section being kept the same.

S. T.

**11. Theory of Composite Beams and of Composite Columns.** Ariya

INOKUTY. [J. Soc. Mech. Eng. Tokyo, XXV., 75 (1922), 25-31, with fig.]—It is assumed that the contiguous fibres of adjacent prismatic elements of a composite beam undergo the same longitudinal strains, and consequently the corresponding stresses are in the proportion of their respective moduli of elasticity. It is also assumed that any plane cross section of the beam remains plane after deformation. When the prismatic elements are symmetrically disposed with respect to the plane of bending and the external forces on the beam are parallel to and symmetrical with reference to the plane of bending, the expressions for the bending moment  $M$  and the elastic curve of longitudinal neutral axis of the beam are given by

$$M = \frac{f}{y} \cdot \frac{\Sigma(E_r I_r)}{E}, \text{ and } \frac{d^2 v}{dx^2} = \frac{M}{\Sigma(E_r I_r)} \text{ respectively,}$$

in which  $f$  is the normal bending stress at variable distance  $y$  on the section of an element chosen for reference,  $E$  the stretch modulus of that element,  $E_r$  that of the element  $r$ ,  $I_r$  the moment of inertia of the section of the same element.

For a short composite column, the total axial load  $P$  carried by the column is given by  $P = f_c \frac{\sum(E_r A_r)}{E}$ , in which  $A_r$  is the sectional area of the element  $r$  and  $f_c$  the compressive stress produced in a particular element chosen for reference.

For a long composite column of uniform section  $P = \left( \pi^2 \text{ or } 4\pi^2 \text{ or } 2\pi^2 \right) \frac{\sum(E_r I_r)}{l^2}$ , for those in which both ends are jointed, or both ends are fixed, or one end is jointed and the other fixed. Applications to reinforced concrete beams and columns are suggested.

S. T.

**12. On the Bernoulli's Theorem** (Japanese). **Kazu SHÖGENJI**. [J. Soc. Mech. Eng. Tokyo, XXV., **75** (1922), 33-44, with fig.]—Treats of the application of the theorem to the flow of fluid, either non-compressible or compressible, along passages of finite cross section. The difference between the velocity head due to the mean velocity and the mean of velocity heads at all points in a cross section is shown. When the theorem is used for determining the loss of head along passages of varying cross section, the "apparent loss" and the "true loss" should be distinguished, and in this connection Andres' experimental result on the flow of water through diverging passages is discussed.

**13. A Contribution to the Theory of Thermal Stress in a Long Hollow Cylinder.** **Tsuruzo MATSUMURA**. [J. Soc. Mech. Eng. Tokyo, XXVI., **76** (1922), 33-49, with fig.]—The subject of the paper is the finding of the thermal stress in a long hollow cylinder, in which heat is transmitted at a uniform rate from the inner to the outer surface or in the reverse direction, considering the coefficient of thermal expansion and the shearing modulus of elasticity as functions of temperatures. The author succeeded in finding a solution, in which the coefficient and the modulus may be of any form whatever as empirical functions of temperature. Dividing the cylindrical wall into a number of co-axial thin cylindrical layers and assuming the coefficient and the modulus in any one layer as constant, he found the radial, tangential and axial stresses at any point of any layer. He finally took the number of layers as infinite in order to arrive at the exact solution.

He further obtained the expressions of the radial, tangential and axial stresses, considering the coefficient and the modulus as well as the Poisson's constant as functions of temperature.

Author.

**14. The Structure of Iron and Steel, and the X-Ray Analysis** (Japanese). **Kōtaro HONDA**. [J. Soc. Mech. Eng. Tokyo, XXIV., **76** (1922), 1-8, with fig.]—This paper contains a general review of the recent progress in the knowledge of the structure of iron and steel made here and abroad, especially with reference to the X-ray analysis. The main points are as follows:—

(1) The nature of the X-ray and its mode of reflection by a regular arrangement of atoms are first explained. Then the formations of Laue spots and X-ray spectrum are explained. (2) The present writer has long entertained the view that the  $A_2$  transformation in iron is not a change of phase, that is, a change in the atomic configuration in iron, but a change in the atomic energy going on gradually with the rise of temperature. This view is conclusively proved by the X-ray analysis by Westgren. (3) The  $A_3$  transformation is an allotropic change consisting of the change of atomic configuration from the body-centred cubic lattice to the face-centred one. (4) The present writer has predicted from the physical properties of iron at high temperatures the  $A_4$  transformation to be a reverse change of the atomic configuration from the face-centred to the body-centred, which is after-

wards confirmed by Westgren by the X-ray analysis. Thus four modifications of iron, usually known as  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ , are now reduced to only two, that is,  $\alpha$  and  $\gamma$  irons. (5) With regard to the structure of steel, the martensite has a body-centred cubic lattice with respect to iron atoms, and consists of an aggregate of very fine crystals containing only a few hundreds of atoms. (6) Troostite, sorbite and pearlite are all mixtures of ferrite and cementite. (7) According to Westgren, the crystal of cementite belongs to the orthorhombic system, its base-group containing four molecules of  $Fe_3C$ . Author.

**15. The Effect of Temperature on the Hardness of Metals.** Kiyoshi ITO. [J. Soc. Mech. Eng. Tokyo, XXVI., 76 (1922), 9-25, with fig. and tables.]—The effect of temperature on the hardness of metals has been investigated. Some twenty pure metals and alloys have been tested. The temperature ranged from  $-50^\circ$  up  $+150^\circ C$ . The Brinell hardness tester has been used. From the results of the tests it may be inferred that (1) Hardness increases considerably as temperature falls. (2) The relation between hardness and temperature is expressible by the formula

$$\log H_2 - \log H_1 = \alpha(t_1 - t_2),$$

where  $\alpha$  is the temperature coefficient of hardness. (3) For pure metals, there is a simple relation between coefficient  $\alpha$  and melting point, and this relation is quite similar to that between the temperature coefficient of Young's modulus or torsion modulus and melting point. (4) In rolled and cast specimens of the same pure metals and alloys, hardness and its temperature coefficients are greater in the former than in the latter. Author.

**16. On the Approximate Equation for an Eccentrically Loaded Column.** Kazu SHOGENJI. [J. Soc. Mech. Eng. Tokyo, XXVI., 76 (1922), 27-31, with fig.]—A comparison is made of approximate equations worked out by Inokuty, Müller-Breslau, and Perry, their relative accuracy is shown in a diagram, and the conclusion is reached that the Müller-Breslau formula is the simplest and most accurate.

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## NAVAL ARCHITECTURE (1-8).

1. *On the Technical Rules relating to Ships' Load Lines* (Japanese). Atsumu **SHIGEMITSU**. [J. Jap. Soc. N. A., 30 (1922), 16-60, with fig.]—This paper is made up of two parts, i. e., geometical freeboards of ships, and the draughts proper to their strength.

In the first section, the author discusses, in detail, fundamental features affecting geometical freeboard, such as tabular freeboards, superstructure correction, length correction, sheer correction, etc., and explains the general principles upon which the Japanese Rule is drafted. He also compares the freeboards calculated by several existing rules, showing that the Japanese Rule gives practically identical freeboards with other rules notwithstanding it is much simpler, and more comprehensive than any of the other rules.

In the second section, the author mentions that the standards of strength proposed by the British Load Line Committee in 1915 are adopted with a slight modification in the Japanese Rule. According to the author, the British Committee's standards of strength are not consistent with Lloyd's construction rule.

To show this the author calculated the longitudinal moduli of resistance of existing vessels and confirmed that the Committee's standard in way of deck-opening is too severe for vessels exceeding 330 feet in length and may be decreased without affecting the safety of vessels.

He also mentions that there are considerable differences between the scantlings of frames determined by the British Committee's proposal and by Lloyd's rules, although they agree fairly well in vessels having some definite proportion of principal dimensions. According to the author, the maximum bending moment must be different in vessels having different breadths, but owing to the nature of the problem, it is not easy to find a hard-and-fast relation existing among them. This is an important question of naval architecture which requires further exploration.

Author.

2. *On the Efficiency of Frames and Beams of Various Forms used in Steel Ships* (Japanese). Kaname **INOUE** and Toshio **TAKEMASA**. [J. Jap. Soc. N. A., 30 (1922), 61-89, with fig.]—According to the Japanese Load Line Rules the limit of draught of a steel ship due to the transverse strength of hull is to be determined by the modulus of resistance of the section of the hold frames called "transverse modulus."

The authors give practical methods of comparing the transversal modulus of the frames of various sections with the equivalent standard frames.

Authors.

3. *On the Relation between the Structural Strength and the Load Line of Steel Vessels* (Japanese). Teruo **ONO**. [J. Jap. Soc. N. A., 30 (1922), 90-117, with fig.]—This paper aims at the establishment of general standards for the strength of both longitudinal and transverse structural members of the hulls of steel vessels. To this end the requirements of the rules of the principal registration societies and the recommendations of the British Subdivision and Load Line Committees have been analysed and rational standard strength has been shown. The paper consists of the following chapters:

1. Introduction.
2. Standards for the longitudinal and transverse strength of hull structures.
3. Sectional area of strength decks, and thickness of longitudinal platings.



4. Strength of frames, beams and single bottom floors.
5. Numerical examples.

Author.

4. *On Some Experimental Results with Elliptical Three-Bladed Model Screw-Propellers in Water* (Japanese). Hitoshi YASTUSHIRO. [J. Jap. Soc. N. A., 30 (1922), 118-139, with fig.]—In 1913 methodical experiments with elliptical three-bladed model screw-propellers were attempted at the Naval Experimental Tank in Tokyo. Two hundred models were tested in 1916-1918, after Froude's "in Open" method and some supplementary experiments relating to the following items were carried out for the purpose of determining constants in the thrust and torque formulæ.

1. Relation between developed area and projected area for this type of propeller.
2. Resistance of drag propellers (i.e. propellers without revolutions).
3. Thrust and torque of stationary propellers (i.e. propellers without speed of advance).
4. Virtual pitch for the type of propeller.

The principal dimensions and variations taken for the propellers as well as notations used for representing the results of experiments were as follows:—

$D$  = Dia. of propeller in ft. . . . . 0.8 ft.,

$P$  = Pitch of working surface in ft.,

$d$  = Dia. of boss at center in ft. . . . . 0.18 ft.,

Immersion of propeller axis . . . . . 0.8 ft.,

$V$  = Speed of advance of propeller in 100 ft. per min. . . . . 3,

$R$  = Rev. in 100 per min.,

$T$  = Thrust in lbs. in fresh water (excl. boss. effect),

$Q$  = Turning moment in ft. lbs. in fresh water (excl. boss effect),

$p$  = Face pitch ratio =  $\frac{P}{D}$  . . . . . 0.7 to 1.6,

$a$  = Dev. area ratio =  $\frac{\text{Dev. area in sq. ft. (ex. boss)}}{\frac{\pi}{4} D^2}$  . . . . . 0.4 to 0.8,

Proj. area ratio =  $\frac{\text{Proj. area in sq. ft. (ex. boss)}}{\frac{\pi}{4} D^2}$  . . . . . 0.29 to 0.78,

$t$  = Blade thickness fraction =  $\frac{\text{thick. of blade at boss center in ft.}}{D}$  . . . . . 0.041 to 0.082,

Mean width ratio =  $\frac{\text{Dev. area of one blade (ex. boss)}}{\frac{1}{2} D(D-d)}$  . . . . . 0.27 to 0.54.

#### RESULTS OF EXPERIMENTS.

(1) Careful measurement of developed and projected areas of model propellers were made and the relations as shown in Fig. 2 (omitted) were obtained.

(2) The resistance of drag screw may be represented by the following empirical equation,

$$\frac{T}{D^2 V^2} = a(2.728 - 0.6875 p).$$

This indicates that thickness of blade, within the limit of the variations taken, is independent of the resistance.

(3) The thrust and turning moment of stationary propellers may be represented by,



$$\frac{T}{D P^2 R^2} = f_1(a, p, t) = C_1,$$

$$\frac{Q}{D P^3 R^{2.1}} = f_2(a, p, t) = C_2,$$

and the values of  $C_1$  and  $C_2$  are given in Fig. 6 and fig. 7 (omitted).

In model propellers the turning moment varies with the power of revolution a little larger than 2, and may be closely represented by the exponent 2.1. The reason why the exponent becomes larger than 2 cannot be clearly explained but it is probably due to skin friction or eddying effect.

(4) The ratios of face pitch to virtual pitch, are given in Fig. 8 (omitted).

Author.

**5. Fukao's Patent Oil Lubricated Stern Tube Packing** (Japanese). Junji FUKAO. [J. Jap. Soc. N. A., 30 (1922), 140-154, with fig. and pl.]—According to the author one of the chief disadvantages of existing types of oil lubricated stern tube packings lies in the fact that the lubricant and the sea water are so imperfectly separated by the intervening packing rings that actually they may be taken as being in contact. By the difference of pressures due to the water column outside and the head of oil inside the stern tube, the oil will leak out past the packing rings, or the water will leak in, with consequent loss of oil in the former case and corrosion of the propeller shaft in the latter.

In Fukao's system, the stern tube is provided with passages opening into the stuffing box fitted at its rear end and leading to the shaft tunnel of the ship, thus the pressure in the stuffing box is kept lower than either the pressure due to the water column outside or the head of oil inside the stern tube. Thereby the inside of the stern tube is kept absolutely free from any water which may get in through the stuffing box. Leaking water flows to the tunnel well, passing through tubes fitted outside the stern tube or through holes in the stern tube wall. The lubricating oil which may leak out of the stern tube is collected in a pocket of the stuffing box without coming in contact with any water leaking in from the sea, and thence travels to a collecting tank in the tunnel recess, where it is again pumped through the stern tube. By such an arrangement the corrosion of the propeller shaft, as well as the wastage of oil, is prevented.

Author.

**6. On the Inclination of Screw Propeller Shafts** (Japanese). Shintaro MOTORA. [J. Jap. Soc. N. A., 30 (1922), 155-169, with fig.]—In the investigation of the performance of screw propellers, the centre line of the propeller shaft is generally assumed to be parallel to the direction of advance relative to the water. It is not unusual that the propeller shafts for high speed craft such as T. B. D., motor boats, etc., are considerably inclined to the direction of advance and also in twin, triple and quadruple screw arrangement, the propellers work in wake current the direction of which is generally not parallel to the shafts. In the present paper, the performance of screw propellers advancing obliquely to the water is investigated experimentally with three model screw propellers. The results are shown in seven sets of curves representing thrust, turning moment and efficiency on the base of nominal slip ratio. The general conclusions arrived at are as follows:—

1. The variations of thrust, turning moment and efficiency due to obliquity of stream lines are very small for the range of inclination experimented with.

2. It is evident from theoretical consideration that the resultant of the water pressure on the propeller when the stream lines are not parallel to the shaft, consists of a thrust along the shaft, a turning moment, a lateral thrust perpendicular to the shaft and a moment

about a diameter of the propeller disc. The latter two, which do not exist in a propeller parallel to the stream lines, are liable to cause vibration of the ship. Author.

**7. *An Improvement in Wooden Ship Construction*** (Japanese). Ryohei OGAWA. [J. Jap. Soc. N. A., 31 (1922), 34-49, with fig.]—The author has introduced an improved method of constructing wooden vessels, by which wooden parts are rationally rein-forced by steel. He mentions that he applied his patent construction to about twenty wooden vessels of various kinds and from the experience obtained from actual results he arrived at the following inferences:—

(1) The new system simplifies the construction of wooden ship, and thereby the cost of building is reduced.

(2) The efficiency (strength to weight) of the new composite vessel is superior to that of wooden or steel vessels.

(3) The cost of up-keep is less than that of ordinary wooden vessels.

**8. *On the Drift of Ships associated with the Rolling among Waves*** (Japanese). Kyoji SUYEHIO, Naoshi SATO and Minoru NARUMO. [J. Jap. Soc. N. A., 31 (1922), 145-154, with fig. and pl.]—The authors have shown experimentally that whenever a ship rolls among waves, she drifts in the direction of the progression of the waves, the drift being the stronger the heavier the rolling is. On close examination of the structure of waves, which was done by photographing the traces of the motion of fine particles suspended around a ship's model, it was found that the structure of waves on the weather side is disturbed more conspicuously than on the lee side. As a natural consequence, ship is subjected to a higher push pressure on its weather side than on the other side, and drifts in the direction of the progression of the waves. It is shown in a diagram that the drifting force depends upon the magnitude of the rolling. Authors.

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## AERONAUTICS (1-8).

1. *On the Sound of Aeroplanes and the Structure of Wind.* Torahiko TERADA. [Proc. Phys.-Math. Soc. Japan, Ser. III, 4 (1922), 43-46.]—In considering the fluctuation of sound of an aeroplane heard at a fixed station on the ground, the author supposes for a rough approximation a corrugated boundary in the air composed of a series of convex and concave cylindrical refracting surfaces arranged alternately. If the image of the sound source attain the observer's level at a certain stage as the aeroplane recedes from the zenith, the fluctuation would be most pronounced. The intensity of sound at its maximum is increased in the ratio of  $1:1+b/(r \cos z)$ , where  $b$  is the height of the boundary above the observer,  $r$  the distance of the image from the observer,  $z$  the zenith distance of the source. For a large value of the radius of curvature of the cylindrical refracting surface and for  $z=0$ , the above ratio becomes  $1:1+b/(a-b)$ , where  $a$  is the height of the source above the boundary. An actual example observed by the author on Oct. 2, 1919 is minutely described.  
S. Y.

2. *On the Climbing of an Aeroplane.* Kazu SHÖGENJI. [J. Soc. Mech. Eng. Tokyo, XXV., 73 (1922), 1-34, with fig.]—The power of an aeroplane necessary for climbing is found and the available power of an aircraft engine at different altitudes is given in a simple exponential formula. Then the formulas are deduced for determining the ceiling, velocity of climbing, and time of ascent. The power to be installed in an aeroplane for a given ceiling and the same for a given vertical velocity near the ground are calculated. The conditions for maximum ceiling and maximum vertical velocity are discussed together with the climbing of aeroplanes fitted with supercharged engines.  
Author.

3. *Wind Channel Experiments at the Tokorozawa Aerodynamic Laboratory* (Japanese). Ryujiro FUJII. ["Zatsuroku" of Aeronaut. Research Inst. Tokyo Imp. Univ., 2 (1922), 48-53, with fig.]—The author discuss the sensitiveness of the aerodynamic balance used in the wind channel at the Tokorozawa Laboratory and describes the results of his experiments on the distribution of air speed in the wind channel. Some model experiments on the R. A. F. aerofoils Nos 6, 15 and 19 made in this wind channel are also described and the results are compared with the corresponding records of experiments carried out at the N. P. L. which showed close arrangement. It is concluded that the experimental results worked out in this wind channel might be considered sufficiently reliable.  
S. T.

4. *Water and Alcohol Manometers.* Masami ONO. ["Zatsuroku" of Aeronaut Research Inst. Tokyo Imp. Univ., 3 (1922), 1-7, with fig.]—The author describes the results of calibration of alcohol and water manometers against a Chattock tilting manometer, and states that the alcohol manometer has the advantage of giving more accurate readings than the water manometer, and that in the former the error of indication increases with the inclination of the manometer tube. It is concluded that the water manometer is not suitable for wind channel work.  
S. T.

5. *On German Aero-Engine Carburetors* (Japanese). Osamu ÔTANI. ["Zatsu-

roku" of Aeronaut. Research Inst. Tokyo Imp. Univ., 3 (1922), 62-64, with fig.]—A brief description of various carburetors of German aero-engines. S. T.

6. *The Gyroscopic Action of the Propeller* (Japanese). Ryuziro FUJII. ["Zatsuroku" of Aeronaut. Research Inst. Tokyo Imp. Univ., 3 (1922), 78-82, with fig.]—The formulæ for the components of gyroscopic resistances of two and four bladed propellers were obtained. Numerical evaluations of the resisting couples were made in the case of looping of a Salmson machine. S. T.

7. *On the Longitudinal Stability of Running Bodies* (Japanese). Kazu SHÖGENJI. [J. Soc. Mech. Eng. Tokyo, XXIV., 66 (1922), 1-17, with fig.]

8. *Photographic Study of the Flow of Air through a Centrifugal Fan* (Japanese). Toyotaro SUHARA and Shizutake KAMEI. [J. Soc. Mech. Eng. Tokyo, XXIV., 66 (1922), 31-44, with fig.]

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## TECHNOLOGY OF ORDNANCE (1-4).

1. *On Blasts Using Carlit Explosive* (Japanese). Tsuneo NOHARA. [J. Soc. Ord. and Exp., XVI, 1 (1922), 17-30, with fig.]—Carlit explosive, the perchlorate mixture not containing any nitro-organic-compound, has many prominent properties; stable for storing, safe in handling, powerful in quarrying, capable of blasting earth finely, also violent in the surface of a body to be broken up.

Data of rock blastings, large blasts of well-drilling and tunnel methods, stump blastings and blasts of shearing wood, are given. Author.

3. *Experimental Study of Safety Plugs for Submarine Weapons* (Japanese). Tamotsu AOKI. [J. Soc. Ord. and Exp., XVI, 2 (1922), 53-83, with fig. and tables.]—This paper treats experimentally of safety plugs for submarine weapons such as mines, bombs, etc. In the first place, compressibility of sal-ammoniac, table-salt and sugar were tested. Secondary, the relation between compression and the speed of solution in water of these materials was studied. Thirdly, the change in the form and height of the compressed cylindrical sample was observed. Next, the relation between the rate of decrease of the height and the area of the exhaust holes in the wall of the tube in which the sample was dissolved. Further, the form of the plug for which the height decreases linearly against time was determined. It was found that the required form is a cylinder with a conical cavity. Lastly, the author devised a new apparatus by which any time of safety may be obtained for any temperature of sea water. Author.

3. *Determination of Velocity of a Projectile by Phonetic Circuit-Breakers* (Japanese). Jugo NAGASAWA. [J. Soc. Ord. and Exp., XV., 2 (1922), 59-89, with fig., pl. and tables.]—When a projectile flies with a velocity higher than that of sound, a head wave known as Mach's wave is formed in front of it. Two phonetic circuit-breakers, each of which is so made as to break an electric circuit by the arrival of the said wave, are arranged in the plane of the trajectory, and the instants at which the head wave arrives at the breakers are recorded. In this way the time which passes from the instant at which the wave front arrives at the first breaker to the instant at which the second breaker is actuated may be measured from the record. The mean velocity of the projectile between two points in the trajectory corresponding to the positions of the breakers can be calculated. This paper treats of the theory of the measurements, from which practical formulæ are derived; also tables and diagrams for practical use are added. S. S.

4. *On the Direction of Fibre and its Resistance to Impact* (Japanese). Yoshiichi SIMIZU. [J. Soc. Ord. and Exp., XV., 4 (1922), 171-175, with fig. and tables.]—Generally speaking, the resistance to impact in forging is greater in the direction perpendicular to than that along the fibre. The author entertains the idea that there is some resemblance to timber although its resistance is much smaller, and from his experiments with a number of test pieces of "Hinoki" he arrives at the following expressions:—

$$\rho^2 = b^2 \cos^2(\theta - \alpha) - a^2 \sin^2(\theta - \alpha),$$

where  $\rho$  = the radius vector,

$\theta$  = the angle which the axis of the test piece makes with the direction of the fibre,

$a, b, \alpha$  = certain constants to be determined.

Applying the method of least squares to his experimental results, he works out,

$$a^2 = 75261.7, \quad b^2 = 74715.16 \text{ and } \alpha = 10^\circ.$$

Hence the above expression becomes,

$$\rho^2 = 741715.16 \cos^2(\theta - 10) - 75261.7 \sin^2(\theta - 10).$$

However, this can only be applicable when  $\theta - 10^\circ \leq 44^\circ 54'$  and suitable correction is needed beyond this limit.

T. Matsuyama.

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## ELECTRICAL ENGINEERING (1—58).

1. *On the Induction Synchronous Motor Characterized by Automatic Transition* (Japanese). Tadaoki YAMAMOTO. [Denki Gakkwai Zasshi, XLI, 401 (1921), 875-891, with fig.]—Although the induction motor and the synchronous motor have been developed as different machines, yet they belong to a class of alternating current motors having many common points, such as the same synchronous speed and similar magnetizing characteristics. The induction motor is superior in its starting characteristics, while the synchronous motor excels the former in its operating characteristics. Thus the combination of both characteristics in a motor is desirable, and has been partially realized by adding squirrel cage winding of a certain design to the synchronous motor, by which the scope of its application has been extended in the present stage.

On the other hand, an attempt at the same thing has been made by synchronizing the induction motor and converting it into the synchronous motor at running condition; but the necessity of manual operation by the transition seems to have been the main factor limiting the field of practical application.

The author, with the assistance of Mr. M. Kawarada, succeeded in making the transition from the induction into the synchronous motor perfectly automatic by the proper use of D.C. series machine as the exciter, in which the building-up of D.C. voltage was controlled so as to be in time. Furthermore, by providing high resistance squirrel cages, which act as wedges at once, the torque speed characteristic of induction motors is made substantially equal to that of Boucherot's double squirrel cage type.

By these methods the induction synchronous motor in question can start with full load torque by mere switching and run up to its synchronous speed of its own accord, exerting pull-in torque not less than full load torque.

The experiments made on 75 H.P. motor of such design are described with special reference to the oscillographic records of stator and rotor currents showing that the transition is natural. Author.

2. *Jumps in the Self-excitation of D. C. Generators* (Japanese). Masataro KAWARADA. [Denki Gakkwai Zasshi, XLI, 401 (1921), 891-902, with fig.]—With a fixed resistance in the exciter circuit of a self excited D.C. generator, if the speed is changed or if the resistance is varied with speed kept constant, there will be building up of terminal voltage in accordance with the characteristic curve of the machine. At other times, however, with the above conditions, there will occur fluctuation of terminal voltage. The author presents his theory relative to these phenomena and furthermore touches on the same peculiarity of separately excited D.C. machines. Author.

3. *The Manufacture of Dry Core Paper Cable* (Japanese). Ikutaro FUKUI. [Denki Gakkwai Zasshi, XLI, 401 (1921), 929-948.]—With the great development in telephone and telegraph engineering, the use of dry core paper cable has become very extensive and knowledge of it is becoming essential to all engineers. The author describes the various kinds of dry core paper cables and the manufacturing processes connected therewith, and gives a table of general dimensions and shapes of the materials used in the manufacture of such a cable. Mention is also made of the various types of machinery used in the manufacture of dry core cable and the function each is supposed to perform. For the benefit of those

interested, an account is given of the dielectric and other properties of the materials used in the cable, with two or three examples of cable design. Author.

4. *On the T.D. Squirrel Cage Induction Motor* (Japanese). Jutaro TAKEUCHI. [Denki Gakkwai Zasshi, XLII, 402 (1922), 33-40, with fig.]—In the "Electrical World" page 732, No. 15. Vol. 78. 1921., Mr. J.W. Murry has published a very interesting paper on "Starting an induction motor without compensator" that is to connect a stator winding in extended delta at starting and reconnect the winding in delta when the motor reaches its full speed. The author himself invented the same starting device for the squirrel cage induction motor, three years ago, in 1918, and patented it in Japan. Already hundreds of the patent motors are on the market under the commercial name "T.D. Motor". The author explains here the details of his invention and the general theory of the starting device, finally giving a few experimental results and particulars of the construction of the "T.D. Motor." Author.

5. *Preliminary Note on Mechanical Actions of Sound Produced by Telephone Receiver.* Kanesaburo KUROKAWA. [Denki Gakkwai Zasshi, XLII, 402 (1922), 41-46, with fig. and pl.]—The paper describes with photographic illustrations some remarkable mechanical actions of sound, produced by a telephone receiver traversed by an alternating current of telephonic frequency and rather big amount. They are:

- (I) Attraction or repulsion between a suspended disc and a sounding receiver, etc.
- (II) Pumping action of sound on a receiver, etc. (Remarkable and believed now.)
- (III) Driving of a small wheel by air currents induced by sound and sucking up of powder inside a tube and blowing it out through a side hole, etc. (Remarkable and believed now.)
- (IV) Dancing of grains of powder between the cap of a sounding receiver and a horizontal plate, etc.

General remarks and explanations are also given respectively before and after these descriptions. Author.

6. *On the Formation of Fume Ions in Electrical Precipitation, Part II* (Japanese). Yasujiro NIWA. [Denki Gakkwai Zasshi, XLII, 402 (1922), 47-54, with fig.]—As a continuation of the author's former paper in this Journal of March 1921, few remarks are given on the formation of fume ions in electrical precipitation. The following is the abstract of the papers, part I and part II.

Assuming the fume particle and the ion are conductive spheres, the author derived the theory of formation of fume ions. When the charges on the particle and on the ion are of equal sign, the energy of the system has a maximum value at a certain distance, within which the ion is attracted to the particle. However when the charges are opposite, there acts always an attractive force between them, but this force predominates effectively within a definite distance. These definite distances, the effective distances as called by the author, decrease with the increase of the ratio of the charge on the particle to that on the ion for the former case and increase for the latter. The author considers that the ions which jump in within the effective distances to the particle are attracted and give their charges to it. Thus the larger the charge on the particle becomes the more difficult for the particle to attract the similarly charged ions, while the easier to attract the oppositely charged ions. Finally when the rate of the recombination of similarly and oppositely charged ions to the particle are equal, the charge on the particle becomes a definite value and cannot increase further. The author calculated theoretically their quantitative relation and concluded that the charges on the particle can be approximately represented by  $\frac{1}{2} \times \frac{N'V'}{NV}$  times the charge



of ion ; where  $N, N'$  and  $V, V'$  are the respective numbers of ions per unit volume and relative velocities of ions to the particle. In order to keep the charge on the particle large this ratio should be increased as far as possible and unless the ratio of densities of both kinds of ions be greater than 2 (assuming equal relative velocities) the charge on the particle cannot be definite. From this standpoint the author discussed the charge and the motion of particles in the space between two parallel plate electrodes and theoretically showed the reason why the precipitation efficiency of the treater of parallel plate type is inferior to that of the cylindrical type. He also criticizes the experiments of Dr. Hauer. (Ann. der Phys. Bd. 61, No. 3. 1920) with his own view. The author also treats the effect of temperature. When the temperature of the gas rises, the kinetic energy of ion increases and if this energy becomes so large as to permit the free motion of ions against the attractive force between the particle and the ion, the formation of fume ions becomes very limited. This temperature is calculated to be very much higher (about 3,000°C.) than we may attain in our engineering circle. The formation of fume ions where the particles are not conductive is also treated similarly and it is shown that the limiting temperature is in the range of our attainments. Certain kinds of dusts treated in the electrical precipitation are not conductive. In this case, however, the moisture and other impurities adhering to the surface of the dust are sufficient to give some conductivity. It is natural that such kinds of conductivity are easily affected by a small change of temperature and other gas conditions. The author, from this standpoint, discusses the relation between the precipitation efficiency, the gas condition and properties of particles, and finally concludes that the high temperature of gas and the low conductivity of particle hinder the formation of fume ions and lower the precipitation efficiency. The author showed that these conclusions are well coincident with the working data of the precipitation treater for the gas of 180,000 cub. ft. per min. at the Ashio Smelter of Japan.

Author.

7. *On the Grounding Reactor* (Japanese). Sadatoshi BEKKU. [Denki Gakkwai Zasshi, XLII, 403 (1922), 99-113, with fig.]—With the increase in number of high voltage power transmission systems, the subject of inductive interference to telephone and telegraph circuits has become one of the most important topics of study among transmission and communication engineers. In connection therewith, various means of limiting the ground current have been devised and in Germany the use of grounding reactors is being considered with more or less favor. It is the author's belief that the study of grounding reactors is of paramount importance in Japan in view of the government regulations with regard to grounding. With the use of reactors it will become necessary to investigate the problem of protective relays. In the appendix the theory of the Petersen coil and the quench transformer is presented and later proves the same effect is obtained by using two reactors as with the use of the quench transformer.

The paper is presented under the following topics :—

1. Introduction.
2. Grounding of one phase of a non-grounded three phase transmission circuit.
3. Grounding of neutral through a reactor.
4. Grounding of three phases through three phase reactor.
5. Effects of inductive interference on communication circuits.
6. Conclusion.
7. Appendix.

(A) Petersen's reactor calculation, (B) Quench transformer conclusion. Author.

8. *Theory of Distortionless Alternators* (Japanese). Giichi SHIMIDZU.

[Denki Gakkwai Zasshi, XLII., 403 (1922), 114-170, with fig.]—In September 1918 at the Kwansai sectional meeting of the Institute of Electrical Engineers of Japan, the author presented a paper entitled "Armature reaction and voltage wave form of a single phase generator" and a great deal of data was given on distortionless alternators and other alternators with laminated cylindrical field magnets. The present paper may be considered a presentation of the results of further research conducted by the author on the latter phase.

In working out the theoretical exposition of the fundamental equations of non-transient phenomena of a distortionless A.C. generator with two field magnets, it has become evident that the conclusion arrived at in the previous paper was confirmed by the result of the later investigation. The author derives formulæ for calculation of short circuit current and voltage regulation of distortionless alternator starting from the fundamental equations. A point is brought to our attention that the construction of a distortionless alternator with one field magnet is simpler than with two.

By the proper interpretation of the fundamental equations, a solution of instantaneous current resulting from the load variation may be obtained. The instantaneous short circuit current and its wave form can be obtained by the further elaboration of these equations. Without going through the intermediate steps and introducing the load variation function, the short circuit current can be obtained directly. In case one phase of a three phase or two phase distortionless alternator should be short circuited, the voltage in other phase or phases can be obtained.

It is very interesting to note that the non-transient current of a distortionless alternator with two field magnets is similar to that of a transformer. Also the coefficient  $\sigma$  which equals  $1 - \frac{1}{vV_f}$  (where  $v$  and  $V_f$  are coefficient of magnetic flux leakage of armature and field pieces respectively), so often met with in the treatise of induction motors and transformers, is also applicable to alternators. Author.

**9. The Grounds on a Transmission Line and the Principle of Superposition** (Japanese). **Hidetaro HO**. [Denki Gakkwai Zasshi, XLII., 404 (1922), 193-198, with fig.]—The convenience of applying the principle of superposition of currents and electromotive forces in investigating the phenomena resulting from an accidental ground and its opening on a transmission line, and in explaining the action of the Petersen coil, is pointed out. Author.

**10. Theory of Single Phase Generator** (Japanese). **Giichi SHIMIDZU** and **Keiji ITO**. [Denki Gakkwai Zasshi, XLII., 404 (1922), 199-227, with fig.]—In the first section of the present paper, a solution for the fundamental equation covering steady phenomena is sought; and as a particular case thereof, instantaneous maximum and effective values of steady short circuit currents are calculated; then it is pointed out that by finding an approximate solution for the fundamental equation of short circuit currents, the expression for the steady part agrees well with the solution for the steady short circuit current found at the beginning; the next step is to find the maximum value of sudden short circuit currents. The foregoing solution, as in the case of the previous paper, is found under the following assumptions; that the field poles, are non-salient, that the entire iron core is finely laminated, that the flux in armature and in field windings fluctuates in sine wave form.

In the second section, in one, two or three phase types, the phenomena caused by short circuit taking place between two line terminals is fully explained. It is made evident by

the authors' explanation that, although, hitherto, the expounding on the single phase generator is very far from being thorough, no serious errors can be caused from applying such conception in treating steady short circuit currents because of the fact that the magnetic leakage in the generator is fairly large.

It is shown that the formulae developed by the authors are identical with those given by Boucherot and that any other conception in the past is not trustworthy. About ten years ago, Boucherot obtained the result almost correctly, but for the reason that his presentation of formulae and his mode of explanation were confused, excepting Niethammer reported these formulae, it seems that very few ever attempted to expound, criticise, or apply them.

Authors.

**11. Theory of Two and Three Phase Generators** (Japanese). **Giichi SHIMIDZU** and **Keiji ITO**. [Denki Gakkwai Zasshi, XLII, 404 (1922), 228-251, with fig.]—The paper treats rigorously a theory on two and three phase generators; taking the following assumptions, that the poles are non-salient, that the entire iron core is finely laminated, that the wave form of flux produced in both the armature and field coils is sinusoidal and that inductance of the same is constant and independent of the magnitude of electrical current. The order of presentation is as follows. At first, the authors by seeking complete solutions of fundamental differential equations, determine the instantaneous values of current subjected to sudden changes of load in general. Next, as an illustration of the application of the method, the value of a sudden short circuit current of a generator is calculated. Finally, the foregoing results are compared with those obtained by the interpretation hitherto generally used.

The case in which, however, the field core is made of solid iron is similar to the case of the sine wave alternator that was treated in the article appearing in the previous number.

Authors.

**12. The Grid Potential of a Triode and its Measurement** (Japanese). **Takashi ONO**. [Denki Gakkwai Zasshi, XLII, 404 (1922), 252-257, with fig.]—The Electric field in a triode valve is closely related to the distribution of negative charge in the inter-Electrode space, and the potential distribution is determinate when the plate potential and the filament temperature are given.

In order to conjecture the behaviour of the Electronic space charges, the potential of the freely disconnected grid was measured.

Two methods are proposed for its determination, and it is shown that the results from both methods coincide exactly with each other.

The results of observations on triodes with different characteristics are described, and the physical phenomena in the bulbs are explained.

Author.

**13. Some Researches on Impulse Voltage** (Japanese). **Sadatoshi BEKKU** and **Osamu TANNO**. [Denki Gakkwai Zasshi, XLII, 405 (1922), 263-293, with fig.]—The authors of this thesis are now carrying on a series of experiments on the needle and sphere gap discharge and also on the insulation break down of several fibrous insulating materials with induced impulse voltage in the secondary caused by sudden connection of the primary of a transformer to the direct current source.

In the experiments, while wave form of impulse voltage is examined by means of a static oscillograph, maximum voltage value is constantly measured by kenotron, condenser and quadrant electrometer. The results of the experiments lead to the discovery that



in the spark gap there occurs irregularity of discharge, and that the spark gap as the only means of crest voltage indicator of impulse voltage is not reliable.

The arrangement of the paper is in the following order.

The first article; references to the paper already published on the subject.

The second article; description of impulse circuit set up and a list of some of the instruments employed by the authors.

The third article; magnetization curves of transformer and energy of impulse circuit

The fourth article; wave form of current and electro motive force.

The fifth article; calibration of static crest voltmeter.

The sixth article; discharge in needle gap.

The seventh article; discharge in sphere gap.

The eighth article; influence of the surface of electrodes.

The ninth article; characteristics of some insulation materials under impulse voltage.

1. Press-Pahn, 2. Red rope paper, 3. Vulcanized fibre,

4. Horn fibre, 5. Empire cloth.

The tenth article; cumulative effect. The eleventh article; conclusion. Authors.

**14. On the Behaviour of a Plunger Type Protective Relay** (Japanese). **Yotsuo TORIYAMA**. [Denki Gakkwai Zasshi, XLII., 406 (1922), 377-390, with fig.]—When a plunger type relay is so connected in an electric circuit as to guard against overload, it is sometimes observed that the plunger is first pulled up by the sudden increase of the load current, but even if this over load current is maintained the plunger happens to drop. The cause of this phenomenon might seem to be:

1. The counter e.m.f. induced in the solenoid due to the sudden motion of the plunger; it is however, experimentally affirmed that the pull does not decrease by its movement, and hence the counter e.m.f. is probably not the chief cause.

2. The upward motion of the plunger is to increase the inductance in the secondary circuit of the current transformer. It is theoretically proved that corresponding increase of the primary voltage, and consequently the magnetizing current, might bring about the said disturbance.

That either of these is not the true cause can be understood from the theoretical conclusion, that, so long as the secondary voltage is constant, the magnetic pull does not decrease owing to the plunger motion.

3 The increase of the iron loss in the relay may also be a cause of the phenomenon.

How the magnitude of the pull varies with the initial position of the plunger is then experimentally determined, from which it can be inferred, that, in order to prevent this disturbing phenomenon, the initial position of the plunger i. e. the initial length of the air gap, must be properly selected.

Many informative results have subsequently been obtained about the performance of a plunger type relay by experimentally determining the velocity and the dynamic pull at every point of the travel during the upward motion of the plunger. Author.

**15. Combined T II Type Artificial Electric Lines** (Japanese). **Heichi NUKIYAMA** and **Yōji SHŌJI**. [Denki Gakkwai Zasshi, XLII., 407 (1922), 413-433, with fig.]—As artificial electric lines T line and  $\pi$  line are in common use. They can be designed to represent exactly the voltage and current of a conjugate uniform line at their junctions at a single frequency. When the frequency changes, the character of such an artificial line will deviate from that of a uniform line. If the artificial line is to be used in a definite



range of frequency this error can be made sufficiently small by making the section of the artificial line small. When the length of each section is given, the error due to the change of frequency may be made small by suitable circuit arrangement of the artificial line. It is proposed to combine T sections and  $\pi$  sections for this purpose and utilize the opposite frequency character of them to neutralize the frequency error. Such an artificial line is here called combined T  $\pi$  type artificial electric line. The theory of one kind of such combined T  $\pi$  type line is given. Calculations and experiments of the actual  $\frac{1}{2}$ -section T type,  $\pi$  type and combined T  $\pi$  type are reported. The result is, from a definite combined point of view, in favour of the combined T  $\pi$  type.

Authors.

**16. The Behaviour of Aluminium Cell Arrester** (Japanese). **Hideji YAGI** and **Jusuke OKOCHI**. [Denki Gakkwai Zasshi, XLII, 407 (1922), 470-476, with fig.]—It has previously been pointed out that the Al-cell arrester reveals some remarkable behaviour under the E. M. F. at audio frequencies. Its behaviour under radio frequency E. M. F. is now studied by mean of the Braun tube oscillograph.

The dynamic characteristics and the cyclic current diagrams have been obtained for frequencies varying between 100,000 and 200,000 cycles per sec., from which the wave shape of the current and the potential against time are deduced.

The superior quality of the Al-cell arrester is that the static capacity of the film is of considerable size and that the discharge characteristic is non-disruptive. These superiorities cannot be superseded by any other type of arrester, very probably not ever by the oxide film arrester.

Authors.

**17. Effect of Saturation of Magnetic Leakage Path on the Circle Diagram of the Three Phase Induction Motor** (Japanese). **Jutaro TAKEUCHI**. [Denki Gakkwai Zasshi, XLII, 408 (1922), 491-502, with fig.]—It is a well known fact and one discussed by many authorities, that the saturation of the magnetic leakage path will affect the circle diagram of the three phase induction motor. Mr. B. A. Behrend<sup>(1)</sup> has shown that the circle diagram of the induction motor, which has closed slots, will be greatly deformed from the circle, and recently Mr. H. K. Whitehorn<sup>(2)</sup> has published a very interesting paper which tells us the centre of the circle will be lowered owing to the saturation of the magnetic leakage path of the closed slots. These investigations, however, tell us only the results of experiments and give no idea of how to correct the circle diagram for this effect. The author explains here a new idea for the correction of the circle diagram for the effect of saturation.

The author's principle for the circle diagram is based on the fact that "A circle of current locus, which is constructed from the test results of no load and of short circuit, is only true at a current by which the locked (or short circuit) test is carried out," because the degree of saturation of the current, by which the motor is locked, is practically equal to the degree of saturation of the working condition of the same current.

(1) The Induction Motor—by B. A. Behrend—p. 37 (2nd Ed.)

(2) The circle diagram for closed slots—by H. K. whitehorn—The Electrician—Sept., 16, 1912—p. 316.

Author.

**18. On the Performance Calculation of an Induction Motor** (Japanese). **Satarō AOKI**. [Denki Gakkwai Zashi, XLII, 408 (1922), 503-521, with fig.]—The characteristics of a polyphase induction motor are usually determined from the so-called "equivalent network" as shown in Fig. 2. An induction motor, however, may also be re-

presented by a circuit shown in Fig. 3, which is much simpler for analysis than the circuit shown in Fig. 2.

For the purpose of calculating the performance of an induction motor, a vectorial constant (*Modifying Coefficient*)

$$C = 1 + Y_o Z$$

$$= 1 + (\text{Exciting Admittance}) \times (\text{Primary Impedance})$$

is introduced. The method of calculation, using this Modifying Coefficient, is shown in detail. A method for properly determining the calculating constants from the test data is also suggested.

Finally the application of the Modifying Coefficient to the solution of other electrical engineering problems, such as voltage regulation and other characteristics of transformers, transmission lines, etc., is discussed.

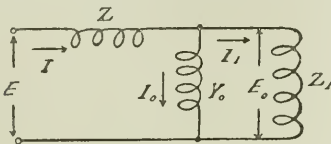


Fig. 2.

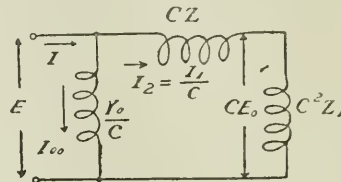


Fig. 3.

Author.

**19. On the Submarine Accumulator** (Japanese). **Sakae MAKIO**. [Denki Gakkwai Zasshi, XLII, 408 (1922), 522-548, with fig.]—This paper relates to the accumulators used in submarines. The accumulators used in submarines differ from those used for stationary and other purposes.

It is true that the chemical actions are the same in all accumulators so far as lead-acid type is concerned, but their design, construction, operation and installation on board the submarine are unique and require special consideration. As they relate to secret affairs of the Navy, nothing has been discussed hitherto, and naturally no paper has yet been written on this special subject.

The author therefore, proceeds to show, as far as permissible, the information which he has obtained from all the available sources of the French, Italian, German and United States Navies as well as that gained as the result of his investigations.

This paper is divided into four principal sections as follows:—

- (I) Introduction.
- (II) Manufacture and properties of submarine batteries.
- (III) Installation and treatment.
- (VI) Operation and characteristics.

Author.

**20. Abnormal Voltages and Protective Devices** (Japanese). **Takeshi NISHI**. [Denki Gakkwai Zasshi, XLII, 409 (1922), 570-577, with fig.]—First the author briefly describes the main causes of abnormal voltage in transmission systems and discusses some of the defects of lightning arresters now in general use. Next the author criticises the recent trend in European practice in connection with protection against abnormal voltages in high voltage transmission systems, and a short account is given of the prominent features of the Petersen coil and similar devices.

The author is of opinion that it is almost impossible to adopt the dead ground system

for high voltage systems in our country owing to considerable induction effect on the communication circuits, and recommends the coil-ground system because of its favourable features of suppressing arcing ground and its slight induction effect on the weak current circuits in comparison with other systems.

Author.

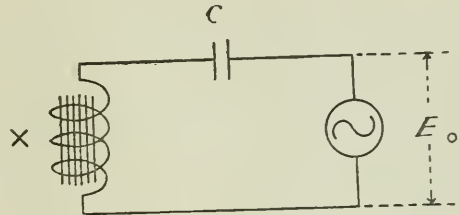
**21. On the Resonance caused by the Petersen Coil** (Japanese). **Sadatosh BEKKU**. [Denki Gakkwai Zasshi, XLII, 409 (1922), 578-582, with fig.]—When the neutral of the transmission circuit is grounded through a reactance, there is a danger of abnormal voltage caused by the unbalance of each phase. In the case of the Petersen coil, since the iron core is used, the reactance changes its magnitude with the intensity of the current. In such a case, the voltage across the Petersen coil, namely the voltage between the neutral and the earth, is theoretically equal to the terminal voltage of the reactance of the equivalent circuit shown in Fig. 4. Therefore the study of the equivalent circuit mentioned above is sufficient for the discussion of the resonance problem in the actual transmission circuit.

If the volt-ampere curve and the phase difference of the reactance coil are given, the voltage across the reactance in the equivalent circuit is obtained graphically, though the process is slightly cumbersome. The voltage across the reactance expressed as a function of the impressed voltage is shown in Fig. 5, there being a certain unstable region which is represented by the dotted lines. It is known from this graphical analysis, since there is certain loss (ohmic loss and iron loss), that if the impressed voltage is less than the critical voltage, there is no danger of abnormal voltage. According to several experiments performed by the author, the actual observed terminal voltage of the reactance agrees fairly well with that obtained by the graphical analysis.

The author concludes that in ordinary transmission circuits the residual voltage will be sufficiently small, less than the critical voltage, therefore there will be no danger of abnormal voltage caused by the resonance, when the Petersen coil is used.

Author.

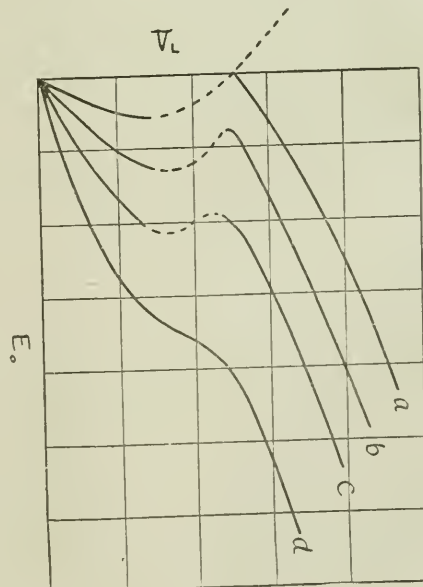
Fig. 4.



$$E_0 = \frac{C_a E_a + C_b E_b + C_c E_c}{C_a + C_b + C_c}$$

$$C = C_a + C_b + C_c$$

Fig. 5.



### 22. Some Calculations relating to Petersen Coil Problems (Japanese).

**Kamaji KATO.** [Denki Gakkwai Zasshi, XLII, 409 (1922), 583-594, with fig.]—In discussing the performance and determining the capacity of the Petersen earth coil, the calculations are first of all necessary. In this paper the earthing current of a 150 kilovolt 140 mile transmission line is computed, to find out that this current does not differ by more than 10%, according to the variation of the positions of the earthed point. The necessary capacity of the Petersen coil for this line is found to be 90 K.V. 115 amp. per circuit. Next the abnormal voltage due to resonance of the coil was calculated, and the value was found to be limited by inserting 50 to 100 ohm resistance in series with the coil. Finally an estimate was made of how the transposition of the overhead lines effects the unsymmetric voltage of neutral point, which proved that two complete turns and more along the whole length of the line are sufficient for practical purpose. Author.

**23. Petersen Earth Coil as a Remedy for Electromagnetic Inductive Interference (Japanese).** **Sadatoshiki BEKKU.** [Denki Gakkwai Zasshi, XLII, 409 (1922), 595-602, with fig.]—This paper is a detailed description of the method, mentioned already in the author's previous paper, of calculating the electromagnetically induced voltage on the weak current line by the accidental grounding of the power line. The assumptions upon which the author's calculation is based are as follows:—

1. The current distribution within the earth crust is always determined, independent of the nature of current, power current or charging current.

2. The electromagnetically induced voltage per unit length of the weak current line at any point is proportional to the magnitude of the current at the opposite point on the power line.

First the author explains the current distribution when one line of the isolated 3-phase system is accidentally grounded, assuming that the line is free from impedance. Fig. 6 is the case when the ground occurs at the sending end; Fig. 7, the case when the ground occurs at the receiving end; Fig. 8, that for the intermediate point.

Based upon the prescribed assumptions, the electromagnetically induced voltage of the weak current line, of

Fig. 6.

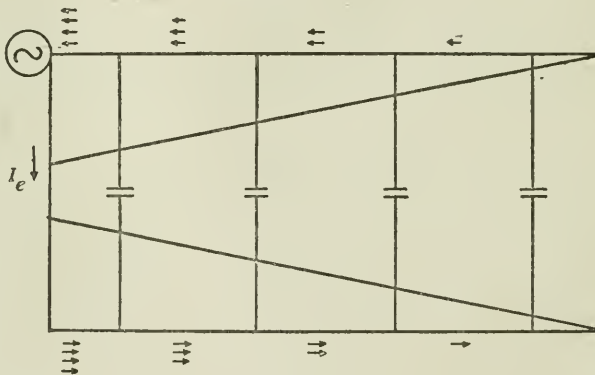
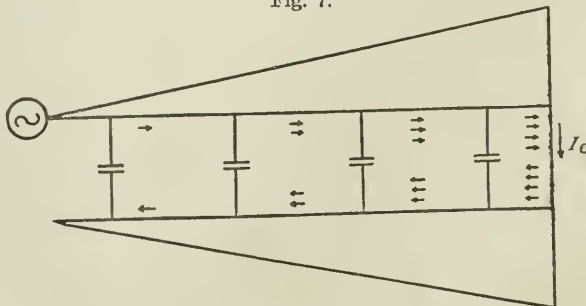


Fig. 7.





equal length with the inducing power line, as a function of the distance  $x$  of the ground from the sending end, is shown in Fig. 9. Thus when the ground occurs at the middle point, the total electromagnetically induced voltage becomes nil.

If the neutral is grounded with the Petersen earth coil, the total induced voltage becomes independent of the position of ground as shown in Fig. 10.

If the neutral is grounded with a non-inductive resistance having the same ohmicity as the Petersen earth coil, the total induced voltage increases greatly as shown in Fig. 11.  $x$  represents the position of ground on the power line from the sending end.

Finally the author calculates for the case in which the induced line is of the quarter length near the receiving end. In this case when the ground occurs at the receiving end with isolated neutral, the total induced voltage becomes  $7/16 E_0$ , with the Petersen earth coil  $1/16 E_0$ , with non-inductive resistance  $10.7/16 E_0$ .

As the remedy for electromagnetic inductive interference, which constitutes a serious complaint in Japan, the Petersen earth coil seems to be very promising.

Author.

Fig. 8.

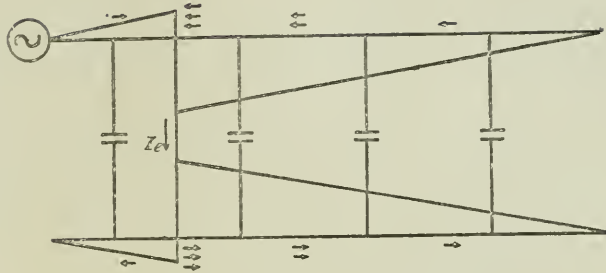


Fig. 9.



Fig. 10.

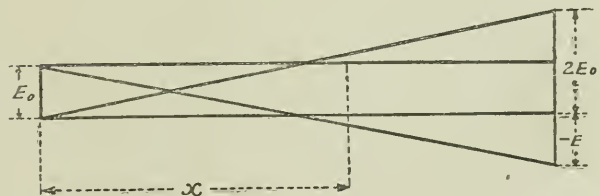
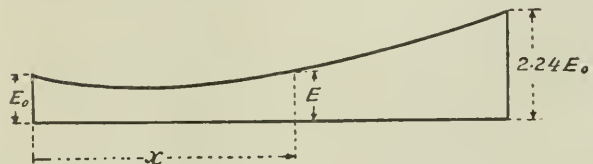


Fig. 11.



24. *On the Design of a Bifilar Non-reactive Resistance Coil* (Japanese). Hei-ichi NUKIYAMA and Yōji SHŌJI. [Denki Gakkwai Zasshi, XLII, 409 (1922), 603-615, with fig.]—A bifilar non-reactive coil usually gives a condensive reactance at high frequency. In

the present paper this frequency error is absorbed at audio-frequency range. The impedance characteristic is shown which resembles that of an electric cable. From this experimental fact, a cable theory of a bifiler non-reactive coil is deduced. Employing an experimental constant, which the authors call apparent dielectric constant, a method for designing a bifiler coil is given by this theory. A practical example of the design of a 100,000 ohm coil, which gives a phase angle less than  $5^\circ$  at frequency of 5,000, is given, assuming the apparent dielectric constant to be fine.

Authors.

**25. On Dielectric Hysteresis and Allied Phenomena of Some Amorphous Insulating Materials** (Japanese). **Hikoo SAEGUSA.** [Denki Gakkwai Zasshi, XLII., 410 (1922), 653-680, with fig.]—This paper contains the following subjects:—

- §1. Introduction.
- §2. Apparatus and Method of Experiment.
- §3. Time Effect.
- §4. Residual Charge.
- §5. Dielectric Hysteresis.
  - 1. Plastic Dielectric Hysteresis.
  - 2. Stationary Dielectric Hysteresis.
- §6. Conclusion.

In the present experiment we investigated 6 amorphous insulating materials, ambroid, paraffin, sulphur, paper, ebonite, glass, and mica (monoclinic crystal, investigated in the former experiment,) by the same method and apparatus as those used in the former investigations (Sci. Rep. Tōhoku, Imp. Univ., Ser. I, 10, 1921, 101; 10, 1922, 437, etc.); and we deduced the following results.

(1). For the amorphous materials, as in the case of nonmetallic isolated crystals, two kinds of dielectric hysteresis are distinct showing their characteristic features.

(2). The plastic hysteresis loop of the amorphous materials does not vary so greatly with time intervals between two successive chargings and dischargings as in the case of isolated crystals. Also, the form of hysteresis loop does not differ so much for different materials as in the case of crystals, but it differs for the different kinds of hysteresis.

(3). The magnitude of hysteresis loop for both plastic and stationary increases in the order of materials, mica, ambroid, paper, sulphur, paraffin, ebonite, glass; and the same tendency holds in the cases of the time effect and the residual charge. Thus we may conclude that a good insulating material has a small time effect, small residual charge and also has a small hysteresis loop of both kinds.

(4). In the amorphous materials, the limit potential (it is the potential from which the stationary hysteresis appears, and at which the relations of the stationary potential due to time effect and saturated value of residual charge to the applied potential begin to deviate from linear laws), is not so definite as in the case of crystals. It is generally observable that the limit potential is defined more definitely from residual charge than from the time effect.

(4). From the present investigation, it is observable that a good insulating material has a small hysteresis, small time effect, and a small residual charge. Hence a good insulating material can be specified by studying any one of the above phenomena. Author.

**26. On the Mercury Arc as an Audio-frequency Oscillator** (Japanese). **Yasushi WATANABE.** [Denki Gakkwai Zasshi, XLII., 410 (1922), 681-693, with fig.] — This is the report of the experimental study of the new mercury-arc method of producing

sustained oscillations of audio-frequency.

The arrangement of apparatus is similar to that of Mr. Vreeland's oscillator, the only difference being that a magnetic field excited by a continuous current is necessary in the new method.

The principle upon which the oscillation is produced is, however, entirely different from that of the Vreeland's oscillator. The method in the latter is a purely electrical one; but, in the former, the purely mechanical oscillation of positive ions takes place between the anodes and the dense cloud of positive ions; this cloud seems to be formed by the action of the magnetic field.

The magnetic field deflects the two arc-streams so as to make them impinge upon each other at a certain point near the surface of the mercury pool.

When no magnetic field is applied, the oscillation is nothing but the oscillatory discharges of a condenser resulting from the fluctuation of the cathode spot on the mercury pool. On closing the magnet coil circuit, the nature of oscillation is immediately changed from electrical to mechanical, and the frequency of the ionic oscillation cannot be controlled by the constants of the oscillation circuit as in the case of the Vreeland's oscillator. It is changed appreciably by the arc length or the position of the magnet by which the arcs are deflected.

Some experiments are also performed for the purpose of comparison on the oscillation without the magnetic field.

Some oscillographic records of the oscillating current are shown.

This report includes the following topics:

- I. Introduction—Ionic Oscillation.
- II. Experimental results with a small bulb.
- III. Experimental results with a large bulb.
- IV. Conclusions.

Author.

**27. Transient Phenomena in a Short Circuited Alternator** (Japanese). **Taro OTAKE**. [Denki Gakkwai Zasshi, XLII., 410 (1922), 694-708, with fig.]—Many papers on the theoretical studies of transient phenomena in a short circuited alternator have already been published, the important ones among them being, so far as the author knows, those due to Berg, Diamant, Boucherot and Biermanns, but these works, though excellent, contain always certain assumptions, the validity of which is more or less dubious.

The following study starts from the generally accepted fundamental equations for a short circuited alternator and using no questionable assumption the solution of these equations is effected by means of an integral equation, and the results thus obtained are with those given by the above cited authors.

The case of polyphase alternators is also considered.

Author.

**28. New Method for the Electrical Machine Design and the Mechanical Device determining Distribution of Loadings.** **Jutaro TAKEUCHI**. [Denki Gakkwai Zasshi, XLII., 411 (1922), 711-744, with fig.]—The author has suggested the "New method of proportional increment" for the determination of the distribution of loadings of electrical machines, in the following sections of this paper:—

- (I) Introduction.
- (II) Fundamental equation for electromagnetic machines.
- (III) Existing theories and rules on the distribution of loadings.
- (IV) "New method of proportional increment" for the distribution of loadings.
- (V) Numerical examples of actual machines.

(VI) Mechanical device for the "New method of proportional increment,"  
"Designograph."

(VII) Conclusion.

Author.

**29. On the Characteristics of the Arc of Tungar Rectifier** (Japanese).

**Yasusi WATANABE.** [Denki Gakkwai Zasshi, XLII, 411 (1922), 746-753, with fig.]—Although the static characteristic curve of the arc of the tungar rectifier is, roughly speaking, falling, the form is not so smooth as that of the carbon arc.

This irregularity is due to the fact that the arc stream changes its position suddenly or gradually, between the anode of graphite and the heated filament as cathode with the result that the arc length varies.

When the arc stream of negative ions converges on the anode impinging on its edge, an oscillating current is produced in the condenser circuit connected across the terminals of the electrodes accompanying a sound in the bulb.

This phenomenon seems to be related to the fact that the negative ions oscillate in the arc vapour simply owing to mechanical causes. The frequency of this ionic oscillation depends mainly upon the terminal voltage and the filament current.

Some remarks on the dynamic characteristics of the rectifying arc of tungar are given, particularly with regard to the effect of the condition of the filament. When the filament current is small, the dynamic characteristic of the arc is not falling but rising distinctly. This may be due to the surface effect on the filament as cathode.

Author.

**30. On One Method of Measuring Rotary Magnetic Hysteresis Losses**

(Japanese). **Tetsutaro MIYAZAKI.** [Denki Gakkwai Zasshi, XLII, 412 (1922), 867-882, with fig.]—Many investigations have been performed on rotary magnetic hysteresis, yet even recent results show a great discrepancy. This inconsistency is thought to be due chiefly to the systematic errors of various measuring methods as well as to the difficulty of extirpation of this phenomenon from its masking effects.

Taking the irregularity of the electromagnetic field brought into existence by the unsymmetrical forms of test pieces and Joule's effect as chief detrimental masks, the author of this paper describes a comparatively accurate method consisting of the measurement of torque of a solid spherical test piece in a rotary magnetic field and the correction of Joule's effect.

The practice of this method is now going on in the author's laboratory.

Author.

**31. Vacuum and Its Measurement** (Japanese). **Kazuo KAMBAYASHI.**

[J. Ill. Eng. Soc., VI, 1 (1922), 15-35, with fig.]—The essential part of the paper explains a new manometer invented by the writer.

The outline of its construction and its action is as follows:—

A thermo-couple of iron and constantan is sealed in a small glass tube (dia.: 0.5 mm.) of thin wall, the air in the tube being exhausted to a pressure of few centimeters in mercury column. The middle part of the glass tube, where the junction point of the thermo-couple is situated, is wound by a fine metal wire which is to be heated by a constant electric current.

Four or more such tubes with heating coils and thermo-junctions are sealed in a glass vessel (A), dia.: 1", length: 8", with a branch pipe. All the thermo-couples and heating coils being connected in series with their respective terminals outside the vessel.

Another glass vessel (B) which contains some glass tubes with a heating coil and a thermo-couple as mentioned above, and of the same form as the vessel (A), is sealed after



being evacuated to a definite vacuum.

The two sets of thermo-couples in the two tubes (A) and (B) are connected in opposite directions and both the heating coils are connected in series. If we connect the glass vessel (A) to a vacuum to be measured and heat the heating coil by a constant current, the reading of a millivoltmeter which is connected to the terminals of the set of the thermo-couples continuously gives a measure of the vacuum in wide range with better sensibility and accuracy.

In this manometer, small fluctuation in heating current or appreciable change of surrounding temperature does not effect the voltmeter reading, because both the thermo-couples in the two glass vessels (A) and (B) are connected in opposition. This is the special merit of the manometer. If the vacuum in the vessel (B) be properly predetermined, the e.m.f. due to the thermo-couples becomes zero when the vacuum to be measured reaches a certain value. So that by means of the manometer with a sensitive galvanometer connected to the thermo-couple circuit, we can know very conveniently whether the vacuum in the tube (A) reaches a predetermined value. In this case the heating current is nearly indifferent to the indication of the galvanometer needle.

Author.

**32. Neon Glow Lamp** (Japanese). Masamichi SŌ. [J. Ill. Eng. Soc., VI, 1 (1922), 36-42, with fig. and pl.]—It seems that research upon the present form of incandescent lamp based on temperature radiation left hardly anything untouched. Thereupon research on the subject of the luminescence of gases and vapors excited by electricity flowing through was taken up and has made much progress. As an example of the present stage of the subject, a Neon Glow Lamp made recently in Europe, that is capable of lighting without a self-starting device even under low voltage, is shown, the construction, operation and characteristics of the tube fully described and illustrated.

Author.

**33. Carbon Filament Incandescent Lamp.** Kikei NISHIKAWA. [J. Ill. Eng. Soc., VI., 2 (1922), 77-95, with fig.]—We have no accurate data regarding the boiling point of pure carbon, and some authorities have reached the conclusion that the melting point of carbon is higher than its boiling point, which we must deny from reasoning of molecular freedom. The melting point of carbon seems to be higher than the boiling point of tungsten.

On the other hand, vaporization of carbon at high temperatures is rendered deceptive by the reaction of impurities contained in carbon, acting as carbon carrying agents.

But to purify the impurities, especially magnesium oxide, to the extent that they do not cause any chemical reactions, is practically difficult. The writer's investigation proceeds to prevent the vaporization due to carbon carrying reaction by using halogen gas to destroy reversible chemical reaction, and has produced a high efficiency carbon incandescent lamp by treating the carbon filament at a high temperature with a chlorine compound of carbon.

Author.

**34. Low Pressure Gas Filled Lamp** (Japanese). Kazuo KAMBAYASHI. [J. Ill. Eng. Soc., VI, 2 (1922), 99-112, with fig.]—In the first section of this paper, loss due to heat transfer in the interior gas, degree of blackening, mean temperature of the gas in the bulb, temperature of the glass wall of the bulb and corona or space current through the inner gas of a gas filled lamp, are investigated as functions of the pressure of the gas in the bulb.

From the result of these investigations, the best pressure of the gas is found to lie between 20 mm. and 100 mm. of Hg column, depending on the voltage and wattage of the lamp.

For a lamp filled with gas of such a low pressure, each of the two junction points of the filament and the leadwires must be protected by a protecting device which is a small conical metallic cone covering the junction points.

In the case of this lamp the nitrogen gas in the bulb is not introduced externally, but the gas is produced from a chemical sealed in the bulb. After roughly evacuating the bulb, this is heated to about 350°C. Then the chemical, Barium-azide, is decomposed to nitrogen and metallic Barium, the latter serving to clean up residual injurious gases in the bulb.

In the last part, some points with respect to design and exhaust of a vacuum lamp are discussed. Author.

**35. On Photo-Elasticity** (Japanese). Tamezō FUKUDA. [J. Ill. Eng. Soc., VI, 2 (1922), 119-151, with fig.]-It is a very important thing to determine the distribution of stresses in a plate of various forms on which forces act. But it is very difficult to do it theoretically. Fortunately Prof. Coker of the the University College in London ingeniously invented an experimental method to determine the stress distribution in a model plate of celluloid by colour effect produced by polarized light, combined with the measurement of change in thickness of the test plate. This paper is intended to explain the theory and the experimental method of this determination.

First it is explained what polarized light is and how it will be produced. Next, the theory of colour-effect of polarized light passed through a crystal plate is explained; this is due to an interference of light. And next it is explained what is circularly polarized light and how it will be produced by using a thin mica plate called quarter wave plate. This circularly polarized light is used for stress determination. If a stressed celluloid plate be examined by circularly polarized light, a coloured light can be obtained like that with a crystal plate. This colour relates to the stress of the test plate. Take another celluloid plate with uniform section and uniform stress, and compensate the colour effect produced by the test plate with the colour effect of this compensation plate; it produces darkness.

From this compensation can be obtained the difference of the principal stresses of the test plate at any point provided with the stress of the compensation plate which can be calculated easily. Next, measuring the change in thickness of the test plate, the sum of the principal stresses of the plate at any point can be obtained from the theory of elasticity. Now combining the value of the sum and the difference of the principal stresses we can get the principal stresses.

To get the lines of principal stress take off the mica plates and use the plane polarized light. The plane polarized light passed through the stressed test plate produces many dark lines. These lines are lines of equal inclination which are loci of the points at which the principal stresses have the same direction. From these lines of equal inclination we can get lines of principal stresses.

Lastly, there are shown experimental results of stress determination of a plate with an eccentric circular hole at the edges of the sides, and with the hole at the principal minimum section, and at the lines of principal stresses. Author.

**36. Grundlage der medizinischen Anwendung der Lichtstrahlen** (Japanisch). Kaichirō MANABE. [J. Ill. Eng. Soc., VI, 3 (1922), 213-222.]-Die Verwertung der Lichtenergie im Organismus, die derselbe durch Auge, Haut und Blut absorbiert, ist durch Anführung einiger experimentellen resp. praktischen Beispiele ziemlich genau beschrieben. Je nach vor-oder nachteiligem Einfluss der Lichtenergie kommen Abwehrerscheinungen resp. Steigerungen der physiologischen Funktion im Organismus zu Tage.

Die Lichtabsorption des Gewebes ist von der Wellenlänge der einzelnen Strahlen abhängig.

Die langweilige Strahlen aber werden manchmal durch Zusatz des gewissen Verfahrens wirksam. Baktericide Wirkung, Wundheilung durch offene Behandlung und Erregung des Nervensystems sind alle günstige Effekte der Strahlen, während Pellagra, Buchweizenkrankheit und Suppuration von Pocken als schädliche Folge vom Licht zu betonen sind. Am Schluss sind die physiologisch psychologischen Wirkungen der einzelnen Farben und der Komplementärefarben angeführt, die der Dekorationsbeleuchtung und der Farbenlichttherapie die wichtigen Stützpunkte geben.

Verfasser.

**37. Light Distribution and Efficiency of Various Kinds of Lamp Fixtures** (Japanese). **Sigehiro SEKI**. [J. Ill. Eng. Soc., IV., 3 (1922), 239-250, with fig.]—The author at first classified in general 300 or more lamp fixtures according to their light distribution and efficiency as measured at the laboratory of the Tokyo Electric Co., and gave each of their characteristics, then he explained in detail with some examples and illustrations.

- (1) Shapes of lamp fixtures and the nature of their reflecting surfaces.
- (2) Kinds of glass.
- (3) The positions of light source.
- (4) Irregularity of reflecting surface.
- (5) Forms of light source and colours of the light which are the main factor affecting the distribution of light.

Author.

**38. The Effect of Magnetic Fields on Electrical Resistance of Some Alloys.** **Juichi OBATA**. [Researches, Electrot. Lab. Tokio, Japan, 101 (1921), 427-446, with fig.]—The author measured, by potentio-method, the change of electrical resistance of these materials such as manganin, constantan, eureka and platinoid at various temperatures between  $-133^{\circ}$  and  $+100^{\circ}$  C. in various magnetic fields up to 20,000 gauss. As the results of the experiment, the following conclusions were drawn.

1. In copper alloys containing nickels or manganese, such as constantan, manganin, eureka etc. the magnetic field always produces a decrease in resistance both in transverse and longitudinal positions.
2. For a given magnetic field an increase in temperature produces a determined magnetic effect in such alloys, no matter how the resistance-temperature relation may be.
3. The molecular configuration of these alloys is thence considered to be of a quite special type, a magnetic field always acting to produce an increase in the free path of conducting electron.
4. In phosphor-bronze and platinum-iridium the effect is quite inappreciable so that the decrease of resistance in magnetic fields may in all probability be attributed to the presence of the magnetic constituents.
5. The decrease in resistance is, in weak magnetic fields, proportional to the square of the field strength.
6. In nichrome the effect of magnetic fields is much more alike to that in pure nickel or iron, whence it may be inferred that some parts of nickel or iron contained in this alloy are left in a free state.
7. The changes in the resistance of these alloys in magnetic fields were found to be of an altogether different character from those of magnetic or non-magnetic pure metals.

Author.

**39. Cross Talks in Lead Covered Paper Telephone Cables** (Japanese). **Kazukiyo OGAWA** and **Kotaro YOSHIDA**. [Researches, Electrot. Lab. Tokio, Japan, 102 (1922), 447-514, with fig.]—The paper deals with the cross talk due to capacity unbalance



in short cables such as are used for the subscriber's line and the inter-office trunk line. The cross talk in the long-distance quadded cable is not entirely dealt with.

The capacity distribution in the two adjacent circuits of the cable is described at the outset. The equivalent network consisting of six condensers is shown to be convenient for the determination of the cross talk. The cross talk current due to the capacity unbalance is computed by the use of that equivalent network. The method of measuring the capacity unbalance is then considered and the proper method of correction suggested, which must be applied when the capacity unbalance is pretty large.

The authors give in the next place the results of measurements of the capacity distribution and its unbalance of some cables of 600 to 25 pairs which were manufactured in our country. The relation between the capacity distribution and the construction and the size of the cable core is discussed with reference to these results.

Finally the abnormal cross talk which occurs when the cable is subject to faults is discussed and the results of experiments are given. Authors.

**40. The Thermoelectromotive Force of Copper-Manganese Alloys and Some Notes on the Electron Theory of Thermoelectromotive Force.** Skezug KIMURA and Tsunehachi AISAWA. [Researches, Electrot. Lab. Tokio, Japan, 103 (1922), 517-529, with fig.]—The thermoelectromotive force of copper-manganese alloys and the effects of iron, nickel and aluminium on it have been investigated, and the following results obtained. The mean thermoelectromotive force of copper-manganese alloys between 0° C. and 100° C. is decisively positive against copper, for instance, an electric current flows from copper to the alloy through the junction kept at the temperature of 100° C. But, in the general formula of thermoelectromotive force  $E=at+bt$ ,  $a$  may vary its sign as the percentage of manganese in the alloy, for instance for copper-manganese alloys containing less than about 12 per cent. of manganese  $a$  may become negative, and for alloys containing greater percentages of manganese  $a$  is positive, while  $b$  is always positive regardless of the percentage of manganese. Even though, therefore, the mean thermoelectromotive force between 0° C. and 100° C. has considerable positive value, the thermoelectromotive force per unit temperature difference at ordinary temperatures may become negative. The cause of the above mentioned facts may be attributed to iron impurity which affects copper-manganese alloys so as to make the thermoelectromotive force more and more negative, while iron itself has positive thermoelectromotive force against copper in this range of temperature. The effect of iron upon the thermoelectromotive force of copper-manganese alloys seems nearly equal in amount to that of nickel. For copper-manganese alloys, manganese content in which is equal in amount to that in ordinary manganin, iron impurity is just sufficient to make the thermoelectromotive force negative at ordinary temperatures. Addition of about one per cent. of iron, which was preferred by Hunter and Bacon, to improve the resistivity temperature coefficient of manganin will cause too much lowering of the thermoelectromotive force of copper-manganese alloys containing about 12 per cent. of manganese. As only thermoelectromotive force at ordinary temperatures is important for manganin, the mean thermoelectromotive force cannot be the measure of its thermoelectrical property. This being the case, the principle of adding a small percentage of nickel to cancel the positiveness of sign of the thermoelectromotive force of copper-manganese alloys must be erroneous. Although it is not yet certain, it can perhaps be said that aluminium affects copper-manganese alloys so as to make thermoelectromotive force against copper only slightly more positive, while aluminium itself has negative thermoelectromotive force against copper. Addition of aluminium may, therefore, sometimes have the advantage of cancelling the effect of iron of excessively lowering the thermoelectromotive force of copper-manganese alloys.



From the above experimental facts it will be seen that any electron theory of thermoelectromotive force, which makes it possible for the thermoelectromotive force of solid solutions against their solvent metals to occur merely in only one sign, either positive or negative, must be useless to explain fully all experimental facts. Present electron theories of thermoelectromotive force face a great difficulty on this point. To overcome this difficulty, it will be necessary to consider that the forces of atoms and molecules acting on free electrons play an important part in the thermoelectromotive force.

Authors.

**41. *The Properties of Enameled Wire for Telephone and Telegraph Use*** (Japanese). **Megumu SUZUKI** and **Kakujiro SHIMIZU**. [Researches, Electrot. Lab. Tokio, Japan, **104** (1922), 541-614, with fig.]—This paper deals with various properties of enameled wire for telephone and telegraph use, taking many sample pieces (B. & S. No. 22) manufactured by ten Japanese and one American makers, criticizes their adaptability for the purpose, and points out moderate criteria for the inspection of enameled wire at the present time.

For judgement of the mechanical properties are selected elongation test, mandrel test pin-hole test, abrasion test, hardness and torsion test, and their advantages and disadvantages are discussed. In addition the testing method of enameling temperature by acetone and carbon bisulphide extraction is mentioned.

Referring to the electrical properties insulation test and break-down test in water and mercury are considered, and the effect of immersion time is described.

Referring to durability, the electrical and mechanical properties are examined after the exposure to quartz mercury vapour are as well as dry and moist heat, and the influence of oxidation of potassium permanganate and hydrogen peroxide is also taken into consideration.

Authors.

**42. *On the Daniell Cell ; the Change of Internal State under Working*** (Japanese). **Masatoshi SONOBE**. [Researches, Electrot. Lab. Tokio, Japan, **105** (1922), 615-650, with fig.]—The electromotive force and the internal resistance of the Daniell Cell as well as their changes under working were investigated in detail. The injurious effects of the mutual diffusion of electrolytes upon the electrical properties of the Daniell Cell are pointed out.

Author.

**43. *High Frequency Wave Telephony applied on a Power Transmission Line*** (Japanese). **Masajiro KITAMURA**. [Researches, Electrot. Lab. Tokio, Japan, **106** (1922), 651-761, with fig.]—This paper deals first with several methods of high frequency wave telephony applied on a high voltage power transmission line, and then are shown some data of experiments which have been recently carried out at a power station of the Ujigawa Hydroelectric Company and which were chiefly related to a newly designed cabinet set lately fitted up at one of the stations.

The methods of telephoning, though the manipulation of the apparatuses is not so simple as that of ordinary battery telephones, have at least one distinct merit, that the system is little affected by the faults arising from outdoor origins which are so often experienced in battery telephony, especially in the case of that along a transmission line. For this reason it is believed to be the most suitable method of communication in the transmission line.

In the first and second sections of this paper are described the outline of the system and some of its historical data. The third section relates to ways of coupling between apparatus and power lines. The methods of coupling are considered, one in which power lines are directly connected with the apparatus through a condenser, and the other in which

power lines are coupled to a short horizontal antenna arranged in parallel to the power lines at a distance. Though the former method is only available under a limited conditions, the latter may be adopted in all cases. The length of the horizontal antenna may be shortened, if required, up to that of one or two spans of transmission towers, and its most desirable length is 300 to 500 meters.

In the fourth section is considered the relation between suitable working wave lengths adopted, the length of power lines, terminal conditions of the lines, etc. The presence of both natural frequency of the line and its higher harmonics is shown by some experiments and the attached curves.

In the fifth and sixth sections means of speech modulation and alarm devices are described.

In the seventh and eighth sections a special method of telephoning using only one high frequency power source all over the network of transmission line is described and the adaptability of a portable telephone set with the system is studied.

In the last section some essential actual data of the experiments with the commercial cabinet telephone set above referred to, together with photographs of it are shown. This set has been designed at the Electro-technical Laboratory, Ministry of Communications, after several experiences in field tests at the Kiugawa Hydro-electric and other Companies since 1918.

The system of high frequency wave telephony working satisfactorily, and being free from injury from atmospheric disturbances, attention is called to the system by those who are concerned with electric power engineering.

Directions for manipulating the cabinet set and specifications of Japanese patents in relation to the system are added as appendices.

Author.

**44. On the Electrical Uses of Chloronaphthalenes** (Japanese). **Wakasaburo OGAWA** and **Katsuhide NISHIUCHI**. [Researches, Electrot. Lab. Tokio, Japan, 107 (1922), 763-792, with pl.]—The authors prepared liquid and solid chloronaphthalenes by passing  $\text{Cl}_2$  gas through fused naphthalene with 1% Fe powder as catalyzer. Liquid chloronaphthalene, b. 230-270°, flash p. 121°, combustion p. 255°, viscosity (REDWOOD) 29 sec. for 50 cc., break down voltage 54,600 v. for 150 mil. Solid chloronaphthalene, m. 85-118°, break down voltage 400 v. per mil. Paraffin was made practically non-inflammable by adding 3 times solid chloronaphthalene. Liquid chloronaphthalene cannot be recommended as an insulating oil because of its strong solvent action upon some insulating materials used in transformer construction and its remarkable carbonization and formation of HCl when exposed to electric discharge. Solid chloronaphthalene is recommended as an insulating material to be used in insulating compounds, varnishes, moulded insulators, dielectrics of condensers, etc. The present situation in Japan as regards the raw materials ( $\text{Cl}_2$  and naphthalene) is also discussed.

Authors.

**45. Theoretical Researches on the Electric Oscillation in Transmission Circuits Caused by the Neutral Reactor.** **Sadatashi BEKKU**. [Researches, Electrot. Lab. Tokio, Japan, 108 (1922), 1-67, with fig.]—The author treated from purely theoretical standpoints the problem of the earth coil used on the European continent by the suggestion of Dr. W. Petersen.

The electrostatic property of the transmission line is represented by a group of condensers, consisting of the self capacities and the mutual capacities. A general expression for the current and voltage in steady state is developed and the author has shown that the determination of the earth coil may be done quite independently of the mutual capacity. After studying

the steady state phenomena, the author starting at the general differential equation of the circuit, obtained the solution for the transient term in a general manner for two systems, single phase and three phase.

When the line is free from fault, the transient term, which occurs in either system, consists of two oscillations. For a given value of capacity, or the transmission, the frequency of one oscillation depends upon the inductance of the power source which is inherent to the system, the frequency of the other depends chiefly on the inductance of the earth coil, and may be made equal to the system frequency by a proper choice of the earth coil. Though the relative magnitude of the two may differ case by case, when the accidental ground is cleared the former oscillation becomes very feeble, and the tendency of re-establishing the arc is greatly lessened by making the frequency of the second oscillation equal to the system frequency, as was pointed out by Petersen. But when a dissonance coil is used, though the current flowing through the accidental ground is not great, the voltage appearing at the terminal of the fault builds up rapidly.

When one line of the three phase system is suddenly grounded, the voltage transient consists of two oscillations, one of which is the inherent oscillation of the system and the other is the one whose frequency is chiefly governed by the inductance of the earth coil. In such a case the voltage of the sound phase above the earth becomes 2~2 times as large as the normal operating voltage, according to the magnitude of the inductance of the earth coil.

With the grounding reactor free from saturation (air core inductance) the author favours the dissonance coil having slightly smaller inductance than the resonance coil, or in other words, the over-compensation of the charging current is favorable. When a slightly dissonant coil is used, the breakage of one line or the switching is believed not to be dangerous.

Though in actual practice the saturation of the reactor will produce some modification, the author believes that his analysis will throw plenty of light on the study of the grounding reactor. The mathematical deductions of minor importance are summarized in the appendix.

Author.

**46. On the Timing Test** (Japanese). **Koichiro YOKOBORI**. [Researches, Electrot. Lab. Tokio, Japan, 109 (1922), 1-43, with fig.]—As the dissolving power of Na sulphide soln. upon tin varies with the S content, it is necessary to define the compn. of the sulphide soln. used in Glover's tinning test. The author prepd. about 70 kinds of sulphide soln. and exad. their solvent action upon tin. 22 per cent. solns. of  $\text{Na}_2\text{S}_2$  and  $\text{Na}_2\text{S}_{2.5}$  were found to be the strongest, while Glover's standard soln. corresponds to 19 per cent. soln. of  $\text{Na}_2\text{S}_4$  and has only a weak dissolving power. Sulphide soln., prepd. by dissolving 10.7 g. of S into hot NaOH soln. contg. 100 g. NaOH and diluting to sp. gr. 1.142 after cooling, has nearly the same strength as Glover's Standard soln. From these results, the author recommends for testing tinned Cu wires (1) the use of the above-mentioned S-NaOH soln., which can be easily prepd. in the same strength at any place and is preferable to Glover's standard soln. because of its stability and definiteness; and (2) the use of 22 per cent. soln. of  $\text{Na}_2\text{S}_2$  to save time compared with Glover's standard soln. Author.

**47. The Organic Accelerators in our own and in Foreign Markets** (Japanese). **Shukusaburo MINATOYA** and **Shun-ichi FUKUDA**. [Researches, Electrot. Lab. Tokio, Japan, 110 (1922), 1-30, with pl.]—The constituents of the various organic accelerators found in our own and in foreign markets are investigated by the authors. The merits and demerits of these accelerators are discussed and some lights are thrown upon the selection of them. In our country only a small quantity of para-nitroso-dimethylaniline



is used. Thiocarbonilide, hexamethylene-tetramine, aldehyde ammonia, diphenyl-guanidine, para-nitroso-dimethylaniline, para-phenylene-diamine, aniline oil, methylene aniline, lead oleate and sodium hydroxide in organic solvents are recommended. Authors.

**48. Temperature Coefficient of the Insulation Resistance of Rubber Covered Wires** (Japanese). Shun-ichi FUKUDA and Shukusaburo MINATOYA. [Researches, Electrot. Lab. Tokio, Japan, **111** (1922), 1-30, with fig.]—The temperature coefficient of insulation resistance of rubber covered wire has been investigated on two kinds of wires—rubber content 40% grade and 20% grade—manufactured by eight Japanese makers, and the mechanical properties and chemical compositions tested and analysed. According to the results, the authors point out that the temperature coefficient of insulation resistance of rubber covered wire not only increases, as hitherto considered, as the rubber content decreases, but it also has a tendency to increase almost in proportion to the amount of organic substances in the rubber compound extracted by various solvents, and that the degree of vulcanization has almost no influence upon the temperature coefficient. It is expected that these facts will be confirmed before long by the further experiments now being carried on. Authors.

**49. On Wave Filter and its Inductance Coil** (Japanese). Teijiro HORIE and Gembei SUGIURA. [Researches, Electrot. Lab. Tokio, Japan, **112** (1922), 1-52, with fig.]—A theoretical and experimental investigation carried on upon wave filter with a view to studying its properties and the condition under which it can attain maximum efficiency, especially in case a receiving instrument is considered, is fully described.

Essential points of the investigation are:

(1) The relation between the voltage  $V_n$  at sending end (or sending current  $I_n$ ) and receiving current  $I_r$  of wave filter may be expressed by following formulae:

$$\begin{aligned} I_n &= I_r \left[ \left\{ \left( \frac{Z_1}{Z_2} \right)^{n-1} + (2n-3) \left( \frac{Z_1}{Z_2} \right)^{n-2} + \frac{1}{12} (2n-4)(2n-5) \left( \frac{Z_1}{Z_2} \right)^{n-3} + \dots \right\} \right. \\ &\quad \left. + \frac{Z_r}{Z_2} \left\{ \left( \frac{Z_1}{Z_2} \right)^{n-1} + (2n-2) \left( \frac{Z_1}{Z_2} \right)^{n-2} + \frac{1}{12} (2n-3)(2n-4) \left( \frac{Z_1}{Z_2} \right)^{n-3} + \dots \right\} \right] \\ &= I_r \left[ A_{n-1} + \frac{Z_r}{Z_2} B_n \right] \\ V_n &= I_r \left[ Z_1 \left\{ \left( \frac{Z_1}{Z_2} \right)^{n-1} + (2n-2) \left( \frac{Z_1}{Z_2} \right)^{n-2} + \frac{1}{12} (2n-3)(2n-4) \left( \frac{Z_1}{Z_2} \right)^{n-3} + \dots \right\} \right. \\ &\quad \left. + Z_r \left\{ \left( \frac{Z_1}{Z_2} \right)^n + (2n-2) \left( \frac{Z_1}{Z_2} \right)^{n-1} + \frac{1}{12} (2n-3)(2n-3) \left( \frac{Z_1}{Z_2} \right)^{n-2} + \dots \right\} \right] \\ &= I_r [Z_1 B^n + Z_r A_n] \end{aligned}$$

where  $Z_1$  and  $Z_2$  are the values of impedance in series and in parallel in each mesh of filter respectively, and  $n$  is number of meshes;  $Z_r$  is impedance of instrument at receiving end.

It is evident from the foregoing formulae that to obtain maximum efficiency  $Z_2$  should be made large and  $Z_1$  as small as possible; yet the relation between  $Z_1$  and  $Z_2$  being so fixed that the condition of increasing  $Z_2$  necessarily increases  $Z_1$  also, as a consequence the impedance of the filter as a whole becomes large; hence high voltage, is required at the sending end to obtain a large receiving current.

Since the voltage is nearly constant in the case of a telephone circuit, it is advisable not to make  $Z_2$  too large in order to get a large receiving current even though the losses in the filter are made somewhat large.



(2) An ideal filter ought to transmit within a definite range current of any frequency smoothly within minimum attenuation. However by resonance effect between the filter and receiving instrument and further by attenuation of the filter being variable depending upon the impedance of the receiving instrument, the wave amplitude of receiving current fluctuates with frequency within the range. To cause a band wave filter, in which one factor—either inductance or capacitance—is omitted, to transmit completely a wide range of frequencies, it is difficult to suppress abruptly currents of frequencies lying just outside either limit of the intended range.

When a five-filter set is used in receiving current irregularity in wave amplitude is less than three filters in a set are used. However, when the number of filters is increased up to ten, hardly any advantage is seen, besides the losses augment with number. In usual practice, therefore, five filters are sufficient.

In the case when either three or five filters are used, by choosing proper values of impedance for  $Z_1$  and  $Z_2$  transmission losses may be made one or two miles (in standard cable).

In addition, the paper describes the results of an experiment conducted using various series of fine iron wire core and thin sheet iron, in an attempt to reduce the value of  $R/L$  of inductance coils.

Authors.

**50. Concentric Form Standard Cells.** Yuichi ISHIBASHI. [Researches, Electrot. Lab. Tokio, Japan, 113 (1922), 1-12, with fig. and pl.]—The Weston cadmium cells in recent use are generally of Lord Rayleigh's form. Lately, C. J. Rodman and T. Spooner devised a cell of concentric form with the object of ensuring uniformity of temperature throughout the containing glass vessel. In trial making of the cell, the present author met with difficulties in cleaning the glass vessel and admitting the necessary materials into it. He subsequently designed cadmium cells of a similar form which differ from the above in that the inner wall is entirely open on the top. In this paper the method of preparation of the new cell and its various characteristics are described. As regards the constancy, temperature coefficient and stability of e. m. f. and the internal resistance, there are no marked differences between the new and the H-form cells. In this connection, careful determinations were made of the change in e. m. f. of a Weston cell; when the temperature of either one of the limbs was varied while that of the other was kept constant, it was found that the e. m. f. varies more than 3/10,000 for a difference of one degree centigrade. For this reason, cells of concentric form are recommended.

Author.

**51. The Electrical Resistivity, and its Temperature Coefficient, of Manganin.** Skezug KIMURA and Kikuji SAKAMAKI. [Researches, Electrot. Lab. Tokio, Japan, 114 (1922), 1-10, with fig.]—The resistivity, and its temperature coefficient, of copper manganese alloys, and the effect of other elements such as Ni, Fe and Si upon them, are investigated.

From their experimental results, the authors have found that a straight copper-manganese alloy can furnish the best manganin, and that there is no need to add other elements to manganin for the purpose of improving its resistivity and temperature coefficient. The straight copper-manganese alloys of about 13 percent manganese made in the authors' laboratory have the following electrical properties:

Specific resistance.....45 microhm-cms.

Temperature coefficient at 22.5°C.....0.00000348.

Authors.

**52. Standardization of Wavemeters.** Akira TSUBOUCHI. [Researches, Electrot. Lab. Tokio, Japan, 115 (1922), 1-67, with fig.]—Since 1919 the establishment of an

accurate standard wavemeter has been undertaken but at the least expense and labour. Among various methods, that suggested by the Bureau of Standards has been adopted at last. The method consists of calculating the inductance and measuring the capacity of a standard wavemeter, and computing the wave lengths from these quantities combined. For checking or correcting the wave lengths, harmonics drawn from a triode generator are made use of. Thus the range of wave lengths from about 200 meters to about 22,000 meters has been covered by the standard wavemeter.

The primary elements of the wavemeter consist of a single turn square coil and a Bureau of Standards type standard variable air condenser. At low frequency the calculated inductance of the square coil with leads has been 7,410 centimeters and the measured value 7,412 centimeters, which are in close coincidence. But, as the variation of the inductance value of the square coil due to frequency has been expected to be rather great, it has been then calculated at radio frequency and found to be 7,080 centimeters at  $10^6$  cycles which reaches only about 95.34 per cent. of that at low frequency. The effect of self-capacity of the coil has been considered but found to be negligibly small. The inductance value 7,080 centimeters at  $10^6$  cycles is used as one basis of calculation of wave lengths of the elemental circuit. The capacity of the standard condenser is considered to be constant at all frequencies and is used as the other basis of calculation of wave lengths of the circuit. Thus the range of the wave lengths of the circuit has been from 230 meters to 438 meters.

In order to cover a wider range of wave lengths, a series of eight standard coils of simple forms with larger inductance than that of the square coil has been made. Combining the series of coils and the standard condensers, the required range of the standard wavemeter has been covered.

Knowing the fact that ample harmonics are drawn from the plate circuit of a triode generator, they have been used to the calibration of wavemeter and the harmonics as high as 200th have been detected by means of a crystal detector and a galvanometer.

The triode generator has been worked with a certain wave length and the harmonics obtained step from the fundamental to the highest possible. When the wave lengths of harmonics get at higher order and come within the range of the elemental circuit, the wave lengths have been calibrated by the elemental circuit. The fundamental wave length of the generator has been calculated by the product of harmonic numbers and the corresponding wave lengths given by the elemental circuit and the mean value obtained, from which the wave length of each harmonic has been calculated. From these data, the curves of the standard wavemeter has been plotted. Thus the shortest wave lengths have been carefully calibrated by the elemental circuit and the longer wave lengths calibrated upwards by turns from the standard of the shortest wave length.

The standard wavemeter thus obtained has been compared to the Navy standard which has been calibrated directly with a high frequency machine and the perfect coincidence of them both has been confirmed.

Author.

**53. On the Clear Baking Insulating Varnishes made of Copal and Linseed Oil** (Japanese). Shohei SAITO and Seikichi MIZUSHIMA. [Researches, Electrot. Lab. Tokyo, Japan, 116 (1922), 1-27, with fig.]—This paper briefly reports the results of the work done in our laboratory on the clear baking insulating varnishes made of copal and linseed oil.

Copal was fused at three different temperatures, viz. 160°, 200° and 250° C. Three kinds of boiled oil were prepared with or without driers. Nine samples of insulating varnishes were prepared from three materials and their properties were examined.

The results are summarized as follows.

It is most favorable to stop the fusion of copal when the volatilization loss amounts to 30-35 per cent.

For insulating varnishes, the most suitable ratio between fused copal and boiled linseed oil is 15 : 85 to 20 : 80. The authors recommend the employment of driers in oil boiling as no undesirable effect from their use was observed.

Authors.

**54. Influence of Cold Rolling on the Properties of Electrical Sheet Steel** (Japanese). Yasujiro NIWA and Jujiro MINAMIZAWA. [Researches, Electrot. Lab. Tokio, Japan, 117 (1922), 1-48, with fig.]—In the present investigation the influence of cold rolling on the electrical, magnetic and mechanical properties of sheet steel is treated. Two series of samples are taken; one (series A) is silicon steel and the other (series B) ordinary steel. These two series are subjected to cold rolling from 0.46 mm. and 0.39 mm. to 0.08 mm. respectively, and the electrical, magnetic and mechanical properties at every stage of rolling are measured. The method of measuring magnetic properties is the magneto-meter method.

The rate of increase of hysteresis loss is nearly proportional to the reduction of thickness. Coercivity has similar nature of change as hysteresis loss, while the retentivity does not change appreciably during cold rolling. From B-H curves at different reductions of thickness the magnetizing force corresponding to 3,000B, 6,000B, and 10,000B, the maximum permeability, magnetic induction and magnetizing force corresponding to maximum permeability, etc., are obtained. The magnetizing forces for 3,000B and 6,000B increase gradually with the reduction of thickness while that for 10,000B decreases near the final reduction. This is explained by the lack of homogeneity of material. The initial maximum permeability is different for both series while the final values are nearly equal. Also the magnetizing force for maximum permeability increases with reduction, but the corresponding magnetic induction is near 4,000 gauss and does not change appreciably.

The change of tensile strength, elongation and Erichsen value are shown. These properties are very much affected during the initial stage of rolling. It is also to be noted that the change in mechanical properties is always accompanied by the corresponding change in magnetic properties.

As for the electrical resistivities and the specific densities the authors cannot see any remarkable changes from cold rolling.

Authors.

**55. On the Allowable Tensile Stress and Some Mechanical Characteristics of Steel Cored Aluminium Reinforced Cable** (Japanese). Masaie HORIOKA. [Researches, Electrot. Lab. Tokio, Japan, 118 (1922), 1-20, with fig.]—In a high tension transmission system, from the standpoints of mechanical strength of conductor and the corona loss of line, the steel cored aluminium reinforced cable is usually adopted in modern practice.

The author studies the fundamental basis for the calculation of allowable tensile stress in aluminium-steel conductor under the assumption that the aluminium can not share any load beyond its elastic limit. This conception is justified when the mechanical hysteresis of the aluminium portion and its effect upon stress distribution is considered. The gradual removal of the share of load from the aluminium to the steel portion with the repetitions of loading is mathematically treated.

Under the assumption that the cable load is entirely sustained by the steel portion when the elastic limit of aluminium is passed over, stress-strain and stress-elastic modulus curves for composite cables of various values of steel portion  $A_s$  are drawn from the experimental stress-strain curves of component conductors, that is, the elastic modulus of



aluminium and that of steel beyond its elastic limit are taken to be variable and exactly follow the experimental data.

It is found that the maximum durable stress of composite cable occurs at the point of elastic limit of aluminium or ultimate stress of steel according as the steel portion  $A_s$  is less or more than one-tenth of the cable area.

Therefore the allowable stresses in the aluminium portion to string the composite cable with the safety factor  $f$  are given by

$$T_a = \frac{160,000}{f\left(\frac{1}{A_s} - 1 + \frac{30 \cdot 10^6}{M_a}\right)} \quad \frac{\text{lbs.}}{\text{sq. in.}} \quad \text{for } A_s > 0.1,$$

$$T_a = \frac{13,000 + 34,800 A_s}{f\left(1 - A_s + \frac{30 \cdot 10^6}{M_a} A_s\right)} \quad \frac{\text{lbs.}}{\text{sq. in.}} \quad \text{for } A_s < 0.1,$$

where

160,000 lbs. / sq. in.	=	ultimate strength of steel,
13,000	„	= aluminium stress at elastic limit,
34,800	„	= steel stress corresponding at the elastic limit of aluminium
$30 \cdot 10^6$	„	= modulus of elasticity of steel.

For various values of  $A_s$ ,  $T_a$ - $M_a$  curves are plotted inserting different values of  $M_a$  into the above equations. Upon these curves the experimental  $T_a$ - $M_a$  curve is superposed and the intersections thus obtained are the required values of aluminium stress in cable to be strung with the safety factor  $f$ . The curves are drawn for  $f=2$  and 2.5 and it is concluded that in order to string the practical cable of steel portion of ten to twenty per cent. of cable area with the safety factor more than two, the cable should be strung so that the aluminium stress is fifty to twenty per cent. less than that at its elastic limit.

The author concludes that the adoption of cable of about twenty-five per cent. steel area is reasonable to string the cable with the elastic limit of aluminium and the safety factor, two, and also gives a table showing the safety factor of cable of any value of steel portion when it is strung with the aluminium portion at its elastic limit. How to find the practical amount of stress variation which has considerable effect upon mechanical hysteresis phenomena of aluminium, the internal stress due to different expansion coefficients of two metals, and the conditions under severest and hot weathers, are fully discussed. Author.

## 56. On Electro-static Control and Capacity Effects of the Quadrant Electro-meter, and a Method of Power Factor Measurement (Japanese).

Seikichi JIMBO. [Researches, Electrot. Lab. Tokio, Japan, 119 (1922), 1-27, with fig.]—The electrostatic control of the quadrant electrometer has always been well known, but there is no full and detailed description of it. The author has derived a theory for it, and has found that one of the electrostatic control is given by  $w(E_3 - E_1)(E_3 - E_2)$ , and the other by  $v(E_1 - E_2)^2$ ;  $E_1$ ,  $E_2$  and  $E_3$  being the potentials of the two pairs of the quadrants and the needle respectively. Now  $w$  which depends on the inclination of the needle is mathematically treated; when the needle is tilted about its central line, the control is positive and  $w$  is proportional to the breadth of the slit between the two pairs of the quadrants and the square of the slope of the needle with respect to the horizontal plane, but when the needle is tilted about the vertical line to its central line,  $w$  is negative and of the same magnitude as in the above case. For  $v$ , which depends on the above slit, a simple theoretical



account is applied. These can be experimentally determined by means of measurements of period and logarithmic decrement at the damped oscillatory motion of the needle. The results of the above experiment show that  $w/4I$  is  $-10^{-6}$  and  $v/4I$  is  $2.3 \times 10^{-6}$  in this case,  $I$  being the moment of inertia of the moving part, and these results are ascertained in comparison with the characteristics of the electrometer.

The capacity effects of the electrometer are described. The inductional electrostatic control, which takes place at the measurement of charge, is mathematically treated, and the error due to the charging current through the suspending fibre which depends on frequency and wave form is described in the case of the heterostatic mode and the idiostatic mode.

Finally, a new method of power factor measurement by the electrometer is described. A non-inductive resistance and an impedance whose phase angle is required are connected in series, being the common terminal C, the other two terminals A and B. Adjust the non-inductive resistance to give the electrometer no deflection, when the quadrants I and II are connected to A and B respectively, the needle connecting to C,  $\theta_1$  and  $\theta_2$  are the deflection when the needle is connected to B, and when moreover the quadrant I is connected to C, then cosine of the required phase angle is given by  $(1 - \theta_1/2\theta_2)$ . author.

**57. Electric Oscillation in the Three Phase Aerial Line.** Sadatoshi BEKKU. [Researches, Electrot. Lab. Tokio Japan, 120 (1922), 1-21, with fig.]-The total self inductance for commercial power frequency of the aerial line with ground return is far greater than the value calculated by the principle of electric image. The experiments with commercial frequency tell that the voltage in the communication line, induced electromagnetically by the neighbouring power line with ground return, is far greater than the value calculated by the principle of electric image. These facts may be certainly due to the finite conductivity of earth. K. W. Wagner had developed the theory of electric oscillation of parallel lines with the assumption equivalent to the principle of image, and obtained the results that there exist travelling waves on each parallel line propagating with a velocity equal to the light velocity in both directions.

The author has developed the theory of the same problem for any value of the coefficients of magnetic induction and obtained the results that where there are  $n$  wires,  $n$  travelling waves of different propagation velocities exist on each wire in general; for the special case of symmetrical three phase line, which is treated with special interest, the variety of velocity becomes two.

Thus for the symmetrical three phase line, there are two kinds of surge impedance, and attention must be paid to this fact. As may be seen in the fundamental equation, the author did not consider the potential drop along the earth, somewhat contradictory to the supposition of the finite conductivity of earth. The validity of the theory must be checked with experiments on actual transmission lines. However, this theory can be applied without reserve to some kinds of artificial transmission lines. The artificial three phase power transmission line now under construction by the author at the Electrotechnical Laboratory is one example to which the author's theory is applicable. Author.

**58. The Transient Electromagnetic Induction on the Communication Line caused by the Parallel Power Line.** Shohei KUDO and Sadatoshi BEKKU. [Researches, Electrot. Lab. Tokio, Japan, 121 (1922), 1-9, with fig. and pl.] -To prevent the dangerous voltage induced on the telephone and telegraph lines by the accidental ground of the grounded power transmission line, high resistances are used in Japan for the connection of the neutral of power system to the earth.

The voltage induced in the steady state, however, may be suppressed by the insertion of high resistances between the neutral and the earth, but we do not know as to the transient voltage. This paper describes the oscillographic experiments performed by the authors. Practically no danger will be produced on the communication line by the insertion of high resistances between the neutral and the earth.

Authors.

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## MINING ENGINEERING (1-8).

1. *The Nature of the Afterdamp produced by the Explosion of Methane and Air Mixtures* (Japanese). Hidenosuke SANO. [Monthly Rep. C. C. M. A. Japan, XVIII., 221 (1922), 943-946.]—It is usually stated in mining text-books that the explosion of a mixture of air with 9.5-14% of methane produces carbon dioxide, but does not produce carbon monoxide, while the excess of methane remains unburnt.

The author has proved, however, by experiments, that such afterdamp contains both carbon monoxide and carbon dioxide. Author.

2. *The Wearing of Wire Ropes used in Aerial Tramways* (Japanese). Einosuke MIKUMO. [The Suiyô-Kwaishi, III., 10 (1922), 1350-1356.]

3. *The Theory of the Variation of Mine Temperatures* (Japanese). Tatsuro OTAGAWA. [The Suiyô-Kwaishi, III., 10 (1922), 1366-1379.]

4. *On the Treatment of Complex Sulphide Ores* (Japanese). Toshio WATANABE. [The Suiyô-Kwaishi, III., 10 (1922), 111-144.]

5. *Some Studies on Diamond Boring with special reference to the Experiments at Hitachi Copper Mines* (Japanese). Tomiji SUZUKI. [Nihon-Kôgyôkwaishi, Ser. XXXVIII., 449 (1922), 481-495.]

6. *The Utilization of the Waste Liquor from Paper Mills as a Binder for Coal Briquets* (Japanese). Ryuji YAMAMOTO. [J. Min. Met. Soc. Korea, V., 1 (1922), 79-88.]

7. *On the Effect of the Smith-Dunn Compressed-Air Process on the Wurare Oil-Field of Japan* (Japanese). Toshikazu NIIYA. [J. Geol. Soc. Tokyo, XXIX., 349 (1922), 411-427.]

8. *Relation between the Quantities of Oil left in the Reservoir and Specific Gravity* (Japanese). Kunio UWATOKO. [J. Geol. Soc. Tokyo, XXIX., 349 (1922), 428-432.]

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## METALLURGY (1-30).

1. *On the Bessemer Process at the Ashio Copper Mine* (Japanese). **Kumeta MIYAMOTO**. [Nihon-Kôgyôkwaishi, Ser. XXXVIII., 450 (1922), 549-567, with fig.]—At the Ashio Copper Mine a characteristic converting operation has been adopted, which is there called "the leaving-copper continuous operation." In this process, a certain amount of produced copper is left in the converter at the discharging period, the next molten matte is charged on the top of it, and then the next converting is started. This operation increases the thermal capacity of the converter, avoiding crust, and smooth and quick converting is obtained without any fuel and requiring little punching work. The life of the lining is also prolonged by this process, hence the acid process is more economical than basic converting in the case of the barrel type at this mine. H. G.

2. *Experimental Results of Treatment of Dressed Auriferous Sulphide Ores* (Japanese). **Kinnosuke TONE**. [Nihon-Kôgyôkwaishi, Ser. XXXVIII., 451 (1922), 639-644.]—The dressed ore is ground in the Huntington mill with cyanide solution and mercury, and simultaneously cyaniding-amalgamating extraction is accomplished. The residue from this mill is transported to the amalgamating pan and then collected in the precipitating tank. From this tank, the over clear solution is drawn out by the siphon pipe, the residue being treated by the percolation-cyanide process. The extraction is 60% by the first treatment and 50% by the second treatment. H. G.

3. *On Pulverized Coal as Fuel for Copper Blast Furnaces* (Japanese). **Hiroshi ARIIZUMI**. [Nihon-Kôgyôkwaishi, Ser. XXXVIII., 452 (1922), 685-697, with fig.]—At the Hidachi Copper Mine, pulverized coal was used experimentally as a substitute for the tuyere coal. One burner was attached to one tuyere and 90-70 lbs. of pulverized coal burn per hour. After many experiments the possibility of smelting by pulverized coal was ascertained. Moreover, by this process the smelting capacity is increased, fuel is economized, a low grade of fuel is utilized, labour is saved and smooth operation is obtained. H. G.

4. *Report on Experimental Treatment of Ore of the Hidaka Mercury Mine* (Japanese). **A. HEINZERMANN**. [Nihon-Kôgyôkwaishi, Ser. XXXVIII., 452 (1922), 697-703.]—The ore produced from this mine is of very low grade and contains only 0.4-0.5% of mercury, associated with some asphaltum. Hence, by the common distillation process, some tar is produced and mixes with the mercury, thus staining it. At this mine the oxidation-basic process has been attempted. By this process 5% braunite and 10% roasted lime are added to the ore and distilled in retorts. The mercury is obtained in the pure molten state containing neither tar nor mercury dust. H. G.

5. *Experiment on Magnetic Separation of Iron Sand* (Japanese). **Katsumi INOUE** and **Shichizo UMEZU**. [Tetsu-to-Hagane, VIII., 1 and 2 (1922), 19-23 and 77-86, with fig.]—Iron sand in Japan contains titanium from trace to 10%. By magnetic separation some part of the titanium can be taken out from the sand, more efficiently in proportion as the sand is finer, which shows that some titanium is, mixed mechanically in the form of illmenite. It is also confirmed by this experiment that a certain amount of titanium exists in the form of solid solution with hematite, and the conclusion is drawn that its absolute elimination from the sand is impossible. H. G.



6. *On Microscopic Examination of Iron Sand Ore* (Japanese). **Katsumi INOUE** and **Shichizo UMEZU**. [*Tetsu-to-Hagane*, VIII., 4 (1922), 233-241, with phot.]—For the microscopic test iron sand was cemented into molten glass, and, after congealing, grinding and polishing operations were carried out in the same way as for metals. HCl of sp. gr. 1.19 was used as an etching agent. The microscopic examination showed that iron sand contains titanium and revealed a strong magnetic constitution. Besides the two ingredients of magnetite and illmenite, there was also seen distinctly the co-existence of a solid solution of these two substances. This solid solution may be called titani-ferrous magnetite and its amount occupies 90% or more of the total face of sand, contrary to the expectation of a great quantity of magnetite in sand. This titani-ferrous magnetite has as strong magnetic properties as magnetite, therefore the elimination of titanium from iron sand would be quite hopeless by the magnetic separator, however fine it might be ground.

H. G.

7. *Experimental Investigation on Copper Matte showing it to consist of Ag-Sulphide, Cu-Sulphide and Fe-Sulphide* (Japanese). **Korenori NAKAGAWA**. [*Nihon-Kôgyôkwaishi*, Ser. XXXVIII., 499 and 450 (1922), 496-502 and 543-549, with fig.]—Copper matte consists of 3-components  $\text{Cu}_2\text{S}$ ,  $\text{Ag}_2\text{S}$  and  $\text{FeS}$  in fixed proportions, making only one solid solution, or one kind of solid solution at the first period and then two kinds of solid solution at the second period, finally solidifying totally at  $543^\circ\text{C}$ . In another case, from the beginning two kinds of solid solution separate out simultaneously, and solidify totally at  $543^\circ\text{C}$ . The eutectic composition of these 3-sulphides consists of about 83%  $\text{Ag}_2\text{S}$ , and about 12%  $\text{FeS}$  whose crystallizing temperature is  $543^\circ\text{C}$ .

H. G.

8. *On the Life of the Rolling Mill for Steel Plate* (Japanese). **Tunakichi YAMAZAKI**. [*Seitetsu-Kenkyûkwaishi*, 71 (1922), 135-137, with fig.]—The life of the rolling mill has been investigated for six years at the Yahata Imperial Steel Works. The rolling mill used was 3-high rolls, the diameter of each of the upper and lower rolls was 34", and of the middle one, 20". When the rolls were uniformly reduced they could be employed until the upper and lower rolls were reduced to  $23\frac{3}{4}"$  and the middle to  $18\frac{3}{4}"$ . The amount of reduction by one operation averages  $2.2\text{m}/\text{m}$ . Therefore, the life of the rolls would be shortened 1/12 for the larger rolls and 1/8 for the middle roll. The total working time and number of rolling tons is 1,000 hours and 15,000 tons respectively by the larger rolls and 300 hours and 3,500 tons respectively by the middle roll. As to the shortening of the life of roll by breakage 3 considerable factors should be mentioned, (1) a crack on the surface of the rolls created by the rolling materials and by friction, (2) effect of heat conducted by the rolling materials or by friction (3) inattentive operation by exhausted labourers.

H. G.

9. *On the Growth of Cast Iron* (Japanese). **Tario KIKUTA**. [*Tetsu-to-Hagane* VIII., 6 (1922), 417-435, with fig.]—This investigation was undertaken to ascertain the effect of gas as one of the causes of the growth of cast iron by heating. Expansion by the first heating at  $700\text{--}800^\circ\text{C}$ . is almost entirely caused by decomposition of cementite. The growth of gray pig iron by heating passing through  $A_1$  point is due to irregular expansion, producing many cracks and holes near the graphite films. In gas which may oxidize iron, the iron oxide produced fills up these cracks and holes and promotes its growth indirectly only. The growth of white pig iron has come to an end by the first heating at  $800^\circ\text{C}$ . One half of this total expansion is due to decomposition of eutectic cementite, the other half is due

to its nonreversible expansion. The expansion at the high temperature above  $A_1$  depends on gas pressure in iron. A hypothesis on growth by oxidation would be uncertain. H. G.

**10. On the Elongation of Carbon Steel** (Japanese). Yoshitaro FUKUYA. [Tetsu-to-Hagane VIII., 3 (1922), 153-157, with fig.]—Test pieces were heated by an electric resistance furnace connected with a testing machine. The elongation of carbon steel is lowest at 200–300°C. and rather more at the ordinary temperature. Gradually increasing from 400°C., it reaches the maximum value at 750°C. There is a second minimum point at 900°C. and above it the elongation again increases. From this result it is evident that forging of carbon steel is not always rendered easier by raising the temperature. It must be noticed that carbon steel is in a worse condition for forging at about 900°C. As for the minimum elongation at 200–300°C., copper, brass and aluminum also have the same relation. Therefore, in order to work these metals, it is senseless to heat them to these temperatures. H. G.

**11. Investigation of the Spontaneous Changes of Hardening Steel** (Japanese). Tokujiro MATSUSHITA. [Tetsu-to-Hagane, VIII., 7 (1922), 477-488, with fig.]—Steel hardening is accompanied by expansion and contraction. Expansion is due to martensite alternated gradually from obstructed austenite, while contraction is based on the segregation of unstable cementite from martensite. The electric resistance of steel increases distinctly with hardening and decreases with tempering; the former is due to dissolubility of cementite in solid solution. Slow expansion and contraction by hardening always generate heat which is based on transformation, not on yielding strain. H. G.

**12. Investigation of the Hardening Effects of Steel** (Japanese). Tokujiro MATSUSHITA. [Tetsu-to-Hagane, VIII., 8 (1922), 557-567.]—A special self-registering apparatus was designed for experiments on the hardening of iron, and the following effects were observed. Lowering of transformation point varies considerably by cooling speed and carbon content, and there are two distinct points, the one at 550°C., the other at 350°C. If transformation takes place above 550°C., sorbite and pearlite are formed; at about 400°C. troostite is formed, and below 350°C. martensite is formed. From these results, it may be suggested that quenching at first in water and below 350°C. in oil again are the safest quenching methods to obtain great hardness. H. G.

**13. Investigation of the Magnetic Hardness of Hardening Steel** (Japanese). Tokujiro MATSUSHITA. [Tetsu-to-Hagane, VIII., 9 (1922), 629-638, with fig.]—It is shown that proper hardening temperature for structural arrangement of carbon steel can be determined by the maximum point in the magnetic hardness-hardening temperature curve. H. G.

**14. Relation between the Crystalline Structure and Transformation of Steel and its Physico-Chemical Properties** (Japanese). Shonosuke IGUCHI. [The Suiyô-Kwaishi, IV., 1 (1922), 1-66, with fig.]—The Widmanstätten's figure is not formed by direct segregation of ferrite from uniform austenite at  $A_{r_3}$ , but is based on non-carbon ferrite by the agglomeration of carbon atoms after  $A_{r_3}$ . The hardening of carbon steel should be mainly referred to  $A_1$  transformation rather than to  $A_{r_3}$ . Each transformation of  $A_{c_3}$  and  $A_{r_3}$  is reversible but not reversible in so far as concerns the disunion of crystalline constitution. Passing through  $A_{r_3}$ , the crystalline grain undergoes no change, but by  $A_{c_3}$  disunion of the grain is apt to happen immediately. As to nickel steel,

$A_{c_1}$  transformation is lowered by nickel content independently of carbon. According to the tempering curve of common carbon steel,  $\beta$  martensite corresponds to austenite which contains carbon; therefore, no 2 kinds of  $\alpha$  and  $\beta$  exist in martensite. The hardness of nickel steel varies proportionally with the structural fineness of martensite. Existence of carbon promotes the formation of the fine structure of martensite.

H. G.

15. *Effects of Heat Treatment on Muntz Metal* (Japanese). **Simpei TONAMI**. [Tetsu-to-Hagane, VII, 12 (1921), 1145-1154, with fig.]

16. *On the Alloy of Copper-Lead-Antimony System* (Japanese). **Masaharu GOTO**. [Nihon-Kôgyôkwaishi, Ser. XXXVII, 442 (1921), 815-830, with pl., phot. and tables.]

17. *Electrolytic Refining of Lead* (Japanese). **Kojiro NISHIMURA**. [Nihon-Kôgyôkwaishi, Ser. XXXVIII, 443 (1922), 30-38, with fig.]

18. *Electric Zinc Industry* (Japanese). **Toraichi MIYAZAKI**. [Nihon-Kôgyôkwaishi, Ser. XXXVIII, 444 (1922), 109-123, with fig.]

19. *On the Electric Current Density and the Composition of Electrolytes of the Bett's Electrolytic Refining Process of Lead* (Japanese). **Yasuyuki TOBA**. [The Suiyô-Kawishi, IV., 1 (1922), 77-80, with fig.]

20. *On the Reverberatory Furnace Smelting at the Naoshima Smelter* (Japanese). **Fusajiro SARADA**. [Nihon-Kôgyôkwaishi, Ser. XXXVIII, 454 (1922), 816-823.]

21. *Design of the Electric Furnace* (Japanese). **Akira ARAKI**. [Tetsu-to-Hagane, VIII, 7 (1922), 488-505.]

22. *Idea on Smelting Low Phosphor Pig Iron in the Blast Furnace* (Japanese). **Seizo ASAI**. [Seitetsu-Kenkyûkwaï-Kiji, VI, 6 (1922), 14-33.]

23. *On the Gas Producer for Steel Making in Japan* (Japanese). **Seiji TANAKA**. [Nihon-Kôgyôkwaishi, Ser. XXXVIII, 448 (1922), 428-435, with fig.]

24. *On Damage of the Furnace Bottom at the Anzan Iron Works* (Japanese). **Toshisuke MIZUTSU**. [Anzan-Tekkôkwaï-Zasshi, 6 (1922), 425-445.]

25. *On Briquetting Test of the Dressed Iron Ore from the Taikozan Mine* (Japanese). **Shirô ISHIDA**. [Tetsu-to-Hagane, Ser. VIII, 10 (1922), 707-730 with fig.]

26. *On Water-Absorptivity of Bog Iron Ore* (Japanese). **Masana KAWAGUCHI**. [Tetsu-to-Hagane VIII, 10 (1922), 731-737, with fig.]

27. *On Bronze Casting by Iron Mould* (Japanese). **Seijiro SHIMURA**. [The Suiyô-Kwaishi, IV., 1 (1922), 67-76, with fig.]

28. *On the Grain-Size of Metallic Crystals* (Japanese). **Kazuo MORISHITA**. [Seitetsu-Kenkyûkwaï-Kiji, 71 (1922), 138-150, with fig.]

**29. *Examples of the Faults of damaged Machine Tools*** (Japanese). **Yukio NAKAMURA.** [Tetsu-to-Hagane VIII, 10 (1922), 731-737, with fig.]

**30. *Effect of Carbon and Mangan on the Shock Resistance of Steel*** (Japanese). **Shinobu MARUE.** [Tetsu-to-Hagane, VIII, 2 (1922), 86-90.]

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## Vol. III

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## CIVIL ENGINEERING (1—20).

1. *On Storm Flow in Sewerage System* (Japanese). **Masayoshi UEDA.** [J. Civ. Eng. Soc., VIII., 6 (1922), 1167-1324, with fig., pl. and tables.]—The paper explains the deduction of empirical formulæ for the storm flow in a sewerage system with constants depending on the topography of, and the rate of the rainfall in, the basin, from data obtained in Chosen.

2. *Liao River under International Organization* (Japanese). **Bunkichi OKAZAKI.** [J. Civ. Eng. Soc. IX., 4 (1923), 627-634, with pl.]—The Upper Liao River Conservancy works are under the direction of the author who has studied the nature of the river since 1920, and whose proposals for improving the river are adopted by the Liao River Conservancy Board, as was stated in J. Civ. Eng. Soc. VII., 5, 1921. In this paper is given a short historical summary of the recent river improvement work which has been carried out under an international organization, together with the details and stipulations of the new cutting known as Line "A," about 14 miles long.  
Kyosuke Yamazaki.

3. *On the Design and Construction of Quay Walls* (Japanese). **Keigi TAKAHASHI.** [J. Civ. Eng. Soc. IX., 4 (1923), 635-680, with fig., pict. and pl.]—This paper gives the author's proposed design for the construction of the quay wall in Kobe Harbour. Its characteristic points are summarized as follows:—1) the front compartment which is to be filled up with concrete when finished is made much smaller than the back one in order to economize the quantity of concrete used; 2) the back wall is made from 8 ft. to 12 ft. lower than the front and partition walls; and 3) the bottom floor is extended backwards at the foot of the back wall and this extended floor is suspended from the back wall by buttresses. It gives not only a sufficient bearing area for the caisson block but also is utilized as a platform for carrying balance weight. Such a type of quay wall is called "L" type.

The author experimented successfully in caisson launching and sinking by means of a model. The model used was one third the size of an actual caisson. The rate at which water is to be pumped into the front and back chambers during the caisson sinking, and other details also, are given in this paper. By this "L" type of caisson block, about thirty per cent. of the cost of construction can be saved as compared with the usual symmetric type.  
Kyosuke Yamazaki.

4. *On the Evaporation from the Ground Surface* (Japanese). **Shizuo ABE.** [J. Civ. Eng. Soc. IX., 4 (1923), 705-732, with pl., phot. and tables.]—This is a report of an experiment on the evaporation from the ground surface conducted by the author at Kumamoto in Kyushu, Japan, from Feb. to Nov. 1921. The daily observation consisted of weighing a quantity of soil filled into metallic cylindrical vessels, 20 cm. in diam., which were placed on the surface of the ground or in a pit,  $4\frac{1}{2}$  cm. deep, in the ground. One of them was sodded on the surface of the soil to be tested. It was found that the ratio of evaporation from the soil to that from the ordinary evaporimeter is much affected by the humidity or wetness of the soil; it has a straight line

relation up to a certain limiting humidity, and beyond this limit it ceases to have any regular relation. The limiting humidity varies according to the places where the vessels are set, while the limiting ratio seems to have a constant value of about 1.2. No regular results could be obtained from the sodded test vessel.

Kyosuke Yamazaki.

**5. Efficiency of Hydro-Electric Plant as affected by Discharge Ratio** (Japanese). **Shizuo ABE.** [J. Civ. Eng. Soc. IX., 5-6 (1923), 903-922, with fig., pl. and tables.]—Generally hydro-electric plants are designed so as to take in a far larger amount of water than the minimum discharge of the river, and consequently, although all the available water is constantly taken in, yet the average output is smaller than the capacity of the plant. The ratio of these two factors, the maximum capacity and the average output of the plant, may be called the "efficiency" of the hydro-electric plant.

Let GP in the diagram be the discharge-duration curve of a river, (the discharge-duration curve is obtained by arranging the discharge for each day in a year in order of magnitude; its form is in most cases hyperbolic, and its right half is nearly a straight line), and let the amount of water to be taken into the plant corresponding to its capacity be ED', then the efficiency of the plant in this case is the ratio of D'EFGD and D'EFGK, or the ratio EM/ED', (the line MN is drawn so as to make the area EFNM equal to the area D'EFGD).

The condition of discharge and discharge-duration curve being given, the efficiency of a hydro-electric plant can be found for any amount of water. It is evident that the efficiency decreases as the maximum amount of water to be taken in increases. For the simplification of the calculation of the efficiency, the author introduced a formula in which the efficiencies corresponding to 185 days water and 275 days water are expressed as a function of the ratio of the amount of water given above to the 355 days water (185 days, 275 days and 355 days water are the discharges corresponding to 185, 275 and 355 days in the duration curve respectively).

Let:—

$w_0$  = 355 days water,

$w_1$  = 275 days water,

$w_2$  = 185 days water,

$a = w_1/w_0$ ,

$b = w_2/w_0$ ,

$E_1$  = the efficiency of the plant corresponding to  $w_1$ ,

$E_2$  = " " " " " " " "  $w_2$ .

Then, taking the discharge-duration curve between 185, 275 and 355 days to be composed of two straight lines, we obtain

$$E_1 = 13.9/a + 86.1\% \quad \dots\dots\dots (1)$$

$$E_2 = 23.1a/b + 13.9/b + 63.0\% \quad \dots\dots\dots (2)$$

The relation between  $a$  and  $b$  is determined by averaging the results of observations at 31 stream gauging stations in Kyushu by the method of least square.

$$a = 0.38b + 0.62 \quad \dots\dots\dots (3)$$

$$E_2 = 28.2/b + 71.8\% \quad \dots\dots\dots (4)$$

Needless to say, these formulas must be modified for rivers in other districts.

Kyosuke Yamazaki.

## 6. *Strength and Proportion of Concrete* (Japanese). **Shukichi NAGAYA.**

[Bull. Imp. Gov. Rwy. Research Office, X., 12 (1922), 2407-2416, with fig.]—In this paper the author gives a summary of the results of tests made on concrete since the year 1918. The following are important points confirmed by the tests. (1) The strength of concrete falls with the increase of the excess quantity of water used in mixing. (2) The proper quantity of water to be used depends on the quantity of cement and sand, the ballast having nothing to do with it. (3) Clay and mud in sand lower the strength of concrete. (4) To make concrete compact, it is advisable to mix sand and gravel in the proportions of 1:2. (5) The essential element making for the strength of concrete is mortar, so that concrete with mortar of 1:3 is weaker than that with mortar of 1:2. Concrete with aggregates of 1:3:6 and 1:3:5: have nearly equal strength. (6) It is advisable to use cement as soon as it is manufactured, no airing being necessary.

## 7. *Some Model Investigations of the Motion of Sand along a Self-Formed Channel.* **Hidesaburo NAKAYAMA.** [J. Fac. Eng. Tokyo Imp. Univ., XIII., 6 (1923), 193-253, with fig., pl. and tables.]—The object of this writer's model investigations is to ascertain the predominating factors in the motion of sand in a self-formed channel.

The flume used was 33 ft. long, 4 ft. wide, 2 ft. deep and was of the tilting type, admitting a maximum bottom slope of one in fifty.

Four kinds of sand were used with the following sizes of grains.

Grade of sand	Sizes of grains	
	Pass meshes clear of sieve.	Stop at meshes clear of sieve.
A	2.5 mm	0.47mm
B (Finer)	0.47mm	
C (Coarser)	6.0 mm	1.5 mm
D (Mixed)	$\frac{1}{3}A + \frac{1}{3}B + \frac{1}{3}C$	

At first the mean velocity  $V_r$ , at which the rolling of sand at the bottom of the channel begins, is determined. The relation is expressed in the following way.

For A class sand	$V_r = 1.875 II^{0.5}$
For B class sand	$V_r = 2.14 II^{0.662}$
For C class sand	$V_r = 2.51 II^{0.263}$
For D class sand	$V_r = 2.467 II^{0.471}$

Next, experiments to determine the volume of sand carried along the bottom of the channel were tried with the following range.

- A. Discharge. 1. Varying flow. Curve A. Max. discharge 0.2 cub. ft. p. s.  
Duration 36 min.  
Curve B. Max. discharge 0.456 cub. ft. p. s. Duration 42 min.

2. Constant flow. Discharges 0.273, 0.371, 0.432, 0.486 and 0.537 cub. ft. p. s. Duration 40 min.-60 min.

B. Bottom slope. Up to one in fifty.

The experiments were usually with a single flow but sometimes with repeated flow or sand feedings.

#### Conclusion.

Within such restricted conditions, possible variations of bottom slopes, discharges, modes of flow etc. were experimented with and the results obtained therefrom show that the relation between  $\frac{q_s}{q(V^2 - V_r^2)}$  and  $I$  is in the form of

$$\frac{q_s}{q(V^2 - V_r^2)} = \alpha + \beta I$$

where,  $V$  = mean velocity of current in ft. per second.

$V_r$  = mean velocity of current at which rolling of sand begins in ft. per second.

$q$  = discharge of water in cub. ft. for time  $t$ .

$q_s$  = volume of sand carried along bed of water course in cub. ft. for time  $t$ .

$I$  = mean slope of water surface during time  $t$ .

The values of  $\alpha$  and  $\beta$  obtained from the experiments are tabulated as follows.

	Kind of sand	Station	No. of experiments	Mean value of $\alpha + \beta I$
Constant flow	<i>A</i>	st. 14*	35	0.101 $I$ - 0.00005
	<i>B</i>	"	5	0.158 $I$ - 0.00028
	<i>C</i>	"	5	0.248 $I$ - 0.00169
	<i>D</i>	"	4	0.292 $I$ - 0.00102
Varying flow with sand <i>A</i>				
Curve	<i>A</i>	st. 16	7	0.319 $I$ - 0.00066
	<i>B</i>	"	13	0.17 $I$ + 0.00005

\* st. 14 means 14 ft. from the inlet.

Author.

**8. A Flaw Detector for Steel Rails** (Japanese). **Masuhiko SUZUKI**. [Bull. Imp. Gov. Rwy. Research Office, XI, 1 (1923), 11-41, with diag. and fig.]—The usual practice in testing the quality of rails is to pick one out of a specified number, and to test it to destruction. The test is unreasonable and expensive. To improve the method of testing, the author, under Dr. Honda's guidance, has studied the subject and has found a method based on the behaviour of steel in a magnetic field, showing variations in permeability with changes in cross section and in structure, physical as well as chemical. The apparatus devised for the purpose consists of a striding horse shoe magnet and a secondary coil hanging therefrom across the magnetic field. The presence of a flaw changes the number of the leaking magnetic force line, whereby an electric current is induced in the secondary coil, which will then be indicated by the D'Arsonval galvanometer attached thereto. The apparatus may also be used with advantage in testing metallic bars, shafts, steel pipes, cables, or wire ropes.

Kyosuke Yamazaki.

**9. Proposals for a Standard Rail Length in Japan** (Japanese). **Yutaka TANAKA**. [Bull. Imp. Gov. Research Office, XI, 2 (1923), 213-241, with diag.]



—From actual observations of temperature and from the data given in the Report of the Tokyo Central Meteorological Observatory, the following empirical formula has been obtained :—

$$\theta = 1.44 \times t_{max} - t_{min} + 13$$

where  $\theta$  = max. range of temperature changes in Celsius in rails.

$t_{max}$ ,  $t_{min}$  = max. and min. temperatures as recorded at the Meteorological Observatory.

Dividing the country into three districts with respect to temperature variation, the following ranges are given :

	$t_{max}$	$t_{min}$	$\theta$
I. Southern district	38°C.	-10°C.	77°C.
II. Central district	38°C.	-25°C.	92°C.
III. Hokkaido	35°C.	-40°C.	103°C.

Taking the coefficient of expansion of steel rails to be 0.0000118 and providing an expansion space of 13 mm., including extra allowance of 1 mm., the rail length may be 13 m. in the first district, and 10 m. in the second and third; likewise with the expansion space of the 15 mm., the max. rail length may be 15 m. in the first district and 12 m. in the second and third. The maximum rail length limited by manufacturing and transportation conditions is 18 meters in Japan, and, where the handling is performed by simple manual labor, it is further subject to the following limitation :—

Weight of Rails, Kg/m	Max. Rail Length in Meters	
	For handling by 6 men	For handling by 8 men
30	15	20
37	12	16
50	10	13

From these considerations the author makes the following proposals :

	A	B
Section I	12 meters	15 meters
Sections II & III	10 meters	12 meters

By changing our present standard rail of 10 meters into one of 12 meters, a reduction of ¥124,000 per 60 Km. in cost is estimated. Thus, the cost of construction and maintenance would be much reduced by adopting the proposed standard length.

Kyosuke Yamazaki.

**10. Stresses in the Anchor Block of Penstock Bend** (Japanese). **YU MASUTANI**. [J. Civ. Eng. Soc. IX., 2 (1923), 367-381, with fig.]—The stresses produced

in anchor blocks are (1) those due to the weight of the penstock, (2) thermal stress due to the expansion and contraction of the penstock, (3) those due to water pressure at the bend, and (4) those due to the centrifugal force of the flow of water at the bent.

The following formulas are deduced:

The normal stress =  $\frac{(W+S)l \cos \alpha^1}{2}$  from the upper pipe.

" " " =  $\frac{(W+S)l_1 \cos \alpha_1}{2}$  " " lower "

where  $\alpha^1$  = angle of inclination of the upper pipe to the horizontal,  
 $\alpha_1$  = " " " " " lower " " " "  
 $l$  = distance from the centre of the block to that of the upper one,  
 $l_1$  = " " " " " " " " " " lower "  
 $W$  = weight of water in the penstock per unit length,  
 $S$  = " " pipe per unit length.

The thermal stress =  $L \left\{ S \sin \alpha^1 \pm f(W+S) \cos \alpha^1 \right\}$  from the upper pipe.

" " " =  $L_1 \left\{ S \sin \alpha_1 \mp f(W+S) \cos \alpha_1 \right\}$  " " lower "

where  $L$  = the length of the pipe between the anchor block and the upper expansion joint,  
 $L_1$  = the length of the pipe between the anchor block and the lower expansion joint,  
 $f$  = coefficient of friction between the pipe and the support.

Thermal stress =  $\beta Et \Delta T$ , where the penstock is not provided with expansion joints.

Where  $E$  = stretch modulus of the pipe,  
 $t$  = change of temperature in degrees,  
 $A$  = cross sectional area of the pipe,  
 $\beta$  = coefficient of expansion of the pipe.

The stress induced by the unbalanced water pressure at the bend is shown to be expressed by  $2 \frac{W}{g} V^2 \sin \frac{\phi}{2}$ , where  $V$  = the velocity of water in the penstock,  $\phi$  = the intersection angle at the bend and  $g$  = the acceleration due to gravity.

An example of graphical determination of stress in a penstock is also given.

Kyosuke Yamazaki.

**11. Guard Rails as Wear Reducers** (Japanese). Jintarō MASUYAMA. [Bull. Imp. Gov. Rwy. Research Office, XI., 6 (1923), 1257-1267, with fig.]—According to the experience obtained by the Imperial Government Electric Railway, the life of rails is less than one year. It has been lately found that guard rails, when properly located, are highly effective in reducing the wear. Careful observations were made for one year on a curve of 15 chains in radius and 12 chains in curve length, by laying guard rails for five chains in length. The wear on the inside of the rail head was 5/16 inch in the portion with guard rails, and 9/16 inch in the portion without them, while the wearing of guard rails was only 3/16 inch.

Further investigations have shown that when old rails are so laid on their sides that their flange surfaces stand vertically against the main rails, the best results are obtained. The advantages of such an arrangement are: (1) Facility of electric

insulation, (2) Availability of old rails of almost any kind, (3) Easy regulation of height, (4) Good drainage, (5) No necessity of separators between flanges of main and guard rails, (6) Ease of maintaining exact balance between the rail flanges.

Kyosuke Yamazaki.

**12. On Transition Curves and Cants** (Japanese). **Yutaka TANAKA.** [Bull. Imp. Gov. Rwy. Research Office, XI., 3 (1923), 593-638, with fig.]-It is a common practice to use a parabolic curve of the third order for a transition curve, to obtain a uniform increment of height of the outer rail at railway curves. The consequence is that the rolling stock is subject to vertical as well as lateral shock at the beginning and end of the transition curve. The author deduces the following formulas for the cant to make the change of vertical moment of the rolling stock gradual; (1) Cosine curve  $Z = \frac{h}{2} \left( 1 - \cos \pi \frac{s}{l} \right)$  and (2) Compound reverse curve  $Z = 2h \left( \frac{s}{l} \right)^2$  for  $0 < s < \frac{l}{2}$  and  $Z = h \left\{ 1 - 2 \left( 1 - \frac{s}{l} \right)^2 \right\}$  for  $\frac{l}{2} < s < l$ , where  $l$  = length of transition curve,  $h$  = cant at the end of transition curve and  $Z$  = cant at a distance  $s$  from the beginning of the curve.

Transition curves are worked out for the above cases.

For the cosine curve of cant,

$$\begin{aligned}
 y &= \frac{l}{2R_0} \left\{ \frac{1}{2} \left( \frac{s}{l} \right)^2 - \frac{1}{\pi^2} \left( 1 - \cos \pi \frac{s}{l} \right) \right\} l \dots\dots\dots 0.0 < \frac{s}{l} < 0.325 \\
 &= \frac{l}{2R_0} \left\{ \frac{1}{2} \left( \frac{s}{l} \right)^2 - \frac{1}{\pi^2} \left( 1 - \cos \pi \frac{s}{l} \right) - \frac{1}{6.223} \left( \frac{s}{l} - 0.325 \right)^5 \left( \frac{l}{2R_0} \right)^2 \right\} l \\
 &\dots\dots\dots 0.325 < \frac{s}{l} < 1.0 \\
 x &= s \dots\dots\dots 0.0 < \frac{s}{l} < 0.27 \\
 &= l \left\{ \frac{s}{l} - \frac{1}{3.112} \left( \frac{s}{l} - 0.27 \right)^4 \left( \frac{l}{2R_0} \right)^2 \right\} l \dots\dots\dots 0.27 < \frac{s}{l} < 1.0
 \end{aligned}$$

For the compound reverse curve of cant,

$$\begin{aligned}
 y &= \frac{k^4}{6\lambda} \left( 1 - \frac{z_2}{\lambda^2} \right) l \\
 x &= k \left( 1 - \frac{z_2}{\lambda^2} \right) l \quad \left. \vphantom{\begin{aligned} y &= \frac{k^4}{6\lambda} \left( 1 - \frac{z_2}{\lambda^2} \right) l \\ x &= k \left( 1 - \frac{z_2}{\lambda^2} \right) l \end{aligned}} \right\} \dots\dots\dots 0.0 < \frac{s}{l} < 0.5 \\
 y &= y_1 + \frac{1}{\lambda} \left( z_3 - \frac{\beta_2}{\lambda^2} \right) l \\
 x &= x_1 + \left\{ \left( k - \frac{1}{2} \right) - \frac{\gamma_2}{\lambda^2} \right\} l \quad \left. \vphantom{\begin{aligned} y &= y_1 + \frac{1}{\lambda} \left( z_3 - \frac{\beta_2}{\lambda^2} \right) l \\ x &= x_1 + \left\{ \left( k - \frac{1}{2} \right) - \frac{\gamma_2}{\lambda^2} \right\} l \end{aligned}} \right\} \dots\dots\dots 0.5 < \frac{s}{l} < 1.0
 \end{aligned}$$

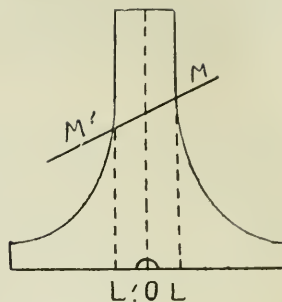
where  $\frac{1}{\lambda} = \frac{l}{R_0}$

$R_0$  = radius of curvature at the end of the transition curve.

Kyosuke Yamazaki.

**13. A Planimetric Scale** (Japanese). **Kazuyuki IIRONAKA**. [Kogaku, X., 1 (1923), 37-40, with fig.]—An area can be measured by the use of a scale having conjugate hyperbolas ( $xy=k^2$  and  $xy=-k^2$ ) as its two edges, and the common asymptote as the third edge as shown in the cut.

The area confined by a line  $MM'$ , the two ordinates through  $M$  and  $M'$ , and abscissa  $LI'$ , has the approximately constant value  $2k^2$ . Making the middle point  $O$  the origin of the curves, the area  $MM'O$  will also remain nearly constant with the value  $k^2$ . The accuracy depends on  $k^2$  and  $MM'$ , an average error not being over  $\frac{1}{2}\%$ .



Kyosuke Yamazaki.

**14. Stability of Structures against Earthquake** (Japanese). **Masao TOFUKUJI**. [J. Civ. Eng. Soc. IX., 5-6 (1923), 865-902, with fig.]

**15. The Streets of Tokyo** (Japanese). **Kiichi TAKENOUCHI**. [J. Civ. Eng. Soc. IX., 5-6 (1923), 819-847, with pl. and table.]

**16. Summary of the Damage to the State Railways by the Great Earthquake of the Year 1923** (Japanese). **Research Off., Dept. of Rwy. of Japan**. [Bull. Imp. Gov. Rwy. Research Office, XI., 8 (1923), 1543-1554, with pict. and pl.]

**17. The Kiaochow-Tsinan Railway Bridge Accident of February 16th, 1923**. **Yutaka TANAKA**. [J. Imp. Rwy. Assoc. XXIV., 4 (1923), 297-308, with pict. and pl.]

**18. On the State of Traffic in Tokyo and its Vicinity** (Japanese). **Keita GOTO**. [J. Imp. Rwy. Assoc. XXIV., 4 (1923), 283-296, with tables.]

**19. Economical Position of the Vertical Wall in Reinforced Concrete Retaining Walls of the Buttress Type** (Japanese). **Toshiyuki OKUBO**. [Kogaku, X., 8 (1923), 403-410, with diag.]

**20. New Method of Calculating Stresses in Reinforced Concrete Girders** (Japanese). **Shūtarō HANABUSA**. [Civil and Arch., II., 2 (1923), 64, with fig.]



## MECHANICAL ENGINEERING (1—5).

**1. *An Experiment on the Flow of Water through a Circular Bend of Rectangular Section.*** Kazuo KUMABE. [J. Soc. Mech. Eng. Tokyo, XXVI., 78 (1923), 49-67, with fig., pl. and tables.]—The pressure distribution due to the flow of water through a circular bend of a closed channel having a rectangular section was measured by a column of  $\text{CCl}_4$ . The mean radius of the bend was 6 inches, and the width and depth of the channel were 2 and  $1\frac{1}{2}$  inches respectively. The pressure was measured at a sufficiently large number of spots on the bottom of the channel to obtain the equi-pressure lines. The velocity of flow ranged from two to five feet per second.

The conclusions are; (1) the flow follows the law of free vortex at the outer side of the bend; (2) at the inner side, unstable turbulent motion seems to exist; (3) the effect of the existence of the bend may be traced over a fairly long distance after the bend; (4) mean pressure rises before the bend and falls after it, the drop of pressure at the exit of the bend being partially recovered after a distance from it.

Author.

**2. *An Explanation of Euler's Theorem on the Momentum of Fluid*** (Japanese). Iwao OKI. [J. Soc. Mech. Eng. Tokyo, XXVI., 78 (1923), 69-78, with fig.]—A mathematical solution of the subject. K. S.

**3. *Column Formula for Steel Towers*** (Japanese). Yoshio SHICHIRI. [J.I.E.E. Japan, XLIII., 419 (1923), 566-579, with fig.]—A study on the strength of columns which is as follows:—

Let  $M$  be the bending moment at a cross section of a column due to axial and lateral loads, and  $M'$  that due to the latter only; then,  $M=ZM'$  in general, where  $Z$  is a certain function of  $\alpha l = \sqrt{\frac{P}{EI}}l$ , the form of which varies according to the nature of the lateral load and the end conditions. The author states that although the value of  $Z$  varies according to imposed conditions, the nature of curves given by  $Z$  and  $\alpha l$  is nearly equal. The end of a compression member of a certain steel joist such as a steel tower for a transmission line can neither be considered as a pin joint nor as being rigidly fixed, but it may generally be considered to have an intermediate nature.

The author makes an assumption that the slope of the elastic line of a column at its end is proportional to the bending moment of the section and puts  $\left(\frac{dy}{dx}\right)_l = -\beta M_l$ , where  $\beta = \gamma \frac{l}{EI}$ .

The pin end corresponds to the case where  $\gamma = \infty$ , and the rigid end to  $\gamma = 0$ , other conditions between these two extremities may be expressed by a proper value of  $\gamma$  which is found experimentally. The author shows a method of obtaining the bending stress induced in a column from a diagram giving the value of  $Z$ , corresponding to  $\gamma$ .

K. S.

4. *Second Report of the Experiment on the Mechanical Efficiency of a Locomotive Engine* (Japanese). **Kenjiro KUWABARA**. [Bull. Imp. Gov. Rwy. Research Office, XI, 1 (1923), 67-75.]

5. *Report of the Experiment on a Feed Water Heater for Locomotive Boilers* (Japanese). **Kenjiro KUWABARA**. [Bull. Imp. Gov. Rwy. Research Office, XI, 1 and 3 (1923), 57-66 and 725-729.]

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## NAVAL ARCHITECTURE (1—19).

### 1. *"Motora" System of Ship-stabilizer* (Japanese). **Shintaro MOTORA.**

[J. Jap. Soc. N. A., **32** (1923), 75-80, with fig.]—The "Motora" system of ship stabilizer is an application of the principle of a ship's rudder to the reduction of the rolling. A pair of fins such as are adopted in the form of the horizontal rudder in a submarine boat, are fitted on each side of a vessel at the bilges and these fins are tilted suitably according to the extent of rolling by means of a steering and controlling gear. Thus the vessel is stabilized against the rolling by the water pressure on the fin surface due to the speed of the vessel. When a vessel which is under way begins to roll, the steering gear is started immediately by means of an automatic controlling apparatus consisting of a gyroscope which controls the steering gear through the precessional movement of the gyroscope effected by the rolling of the vessel. The fin on each side is so tilted by the steering gear that the water pressure on it acts against the rolling of the vessel. In this paper, some of the results of model experiments carried out at the Nagasaki Experimental Tank are given. The experiments were carried out to find the relative damping effect of the naked hull, the bilge keels and the fin stabilizer for free rolling and forced rollings; the effect on the speed and power due to the presence of the fins was also investigated. The results are shown in a set of curves. The general conclusions arrived at are; a) the fin stabilizer is capable of minimizing the amplitude of rolling within only a few degrees even in the worst case where the period of external impulse is coincident with the natural period of the rolling of the vessel; b) the power absorbed either directly or indirectly by the fins may be safely estimated to be less than that absorbed by the bilge keels.

Author.

### 2. *The Effect on Design of the Recent Naval Treaty.* **Robert STOCKER.**

[J. Jap. Soc. N. A., **32** (1923), 103-113.]—The author has analysed the Naval Treaty from the standpoint of a constructor so that it may be easily digested by general readers, explaining the restrictions of the Washington Conference upon the existing capital ships and future warship design, and showing the ever increasing difficulty and importance of the work of naval designers.

T. M.

**3. *Use of Oil as Fuel.* Ernest H. PEABODY.** [J. Jap. Soc. N. A., **32** (1922), 121-133, with fig.]—A brief account of what has recently been done in oil burning in the United States of America is given, particularly as it applies to the use of oil on board ship.

T. M.

**4. *Vibration in Ships.* N. W. AKIMOFF.** [J. Jap. N. A., **32** (1923), 139-145, with fig.]—The author first describes the several causes of vibration in vessels and shows the steps to be taken to overcome the effect of those vibrations produced by the propelling machinery, which is the assembly of the turbine, reduction gear, shafting, propeller, and also of the various auxiliary units. Next, he explains the construction and operation of two types of his balancing machine. He finally points out several erroneous ideas presented by various people in regard to balancing, and concludes that the satisfactory elimination of all destructive and otherwise undesirable vibrations in

ships can only be attained by close cooperation between the naval architect and marine engine designer. T. M.

**5. *Partial Discussion of the Vibrations of Marine Geared Turbines.*** **John H. MACALPINE.** [J. Jap. Soc. N. A., **32** (1923), 149-174, with fig. and tables.]—The author criticises the so-called "Nodal Arrangement of Gear Drives", by which a pinion gear is "tuned", and describes how the introduction of shafts "out of tune" is a perfect protection against damage through vibration. He also describes causes exciting vibration, among which the variation of the pitch of the teeth is stated to be the most serious. After considering the damping and the mode of vibration, the author calculates the probable stresses induced in a turbine shaft. K. S.

**6. *Metropolitan-Vickers Rateau Marine Turbine.*** **H. L. GUY and P. L. JONES.** [J. Jap. Soc. N. A., **32** (1923), 177-219, with fig.]—The principal features of the design and construction of the Metropolitan-Vickers Rateau marine turbines are fully given. T. M.

**7. *The Gyro Ship Stabilizer.*** **Elmer A. SPERRY.** [J. Jap. Soc. N. A., **32** (1923), 225-247, with fig.]—A detailed description of the author's gyro ship stabilizer is given, together with the results of performances on board ships. Short account of the roll and pitch recorder is added at the end of the paper. T. M.

**8. *Strength of Ships.*** **A. M. ROBB.** [J. Jap. Soc. N. A., **32** (1923), 249-276, with a table.]—The paper is a general survey of the subject and is divided into three chapters. In the first chapter the author describes the development in the application of theories of structures to the problem of the strength of ships and gives a record of investigations which have been made. The second chapter deals with the application of existing knowledge, linking up the results obtained by various investigators as far as possible. In the last chapter he endeavours to indicate the direction and character of further efforts. T. M.

**9. *On the Measurement of the Sheer of the Freeboard Deck*** (Japanese). **Ryohei OGAWA.** [J. Jap. Soc. N. A., **33** (1923), 2-4.]—The author recommends the use of the Y-level to measure the sheer of the freeboard deck from his actual experience. T. M.

**10. *On the Refrigerating Ship "Daito Maru"*** (Japanese). **Toshio JIMBO.** [J. Jap. Soc. N. A., **33** (1923), 10-34, with pl. and tables.]—Detailed descriptions of the refrigerating installation and operation on board the "Daito Maru" are given with the author's notes. T. M.

**11. *The Stresses in Rectangular Plates*** (Japanese). **Katsutada SEZAWA.** [J. Jap. Soc. N. A., **33** (1923), 38-48, with fig.]—The stresses in a rectangular plate, which is fixed peripherally and subjected to a uniform normal pressure, are studied. The paper consists of four sections, of which the first and the second give the stresses found mathematically from the differential equation of the equilibrium of a flat plate, the experimental confirmation being shown in the third. In the fourth section it is



shown that the character of the rectangular plate, the ratio of whose sides is two or so, resembles that of the linear beam and further that the stress at the end of the short diameter is nearly twice that at centre.

Author.

**12. *On the Propelling Machinery of the Naval Special Service Ship "Kamoi" and Electric Ship Propulsion* (Japanese). Nobutake YENYA.** [J. Jap. Soc. N. A., **33** (1923), 66-82, with pl. and tables.]—A brief description of the propelling machinery installed on the Naval Oil Carrier "Kamoi" is given in the former chapter, and the general problem of electric ship propulsion is fully dealt with in the latter.

T. M.

**13. *Development in Electric Propulsion of Vessels*. Eskil BERG.** ["Zassan," Jap. Soc. N. A., **32** (1923), 1-19, with fig. and tables.]—The author describes electric ship propulsion from his experience in the General Electric Company and shows its present situation in our marine engineering. He also mentions the Diesel electric drive and the reduction gears.

T. M.

**14. *Strength of Steel Vessels*. Teruo ONO.** [New Ed. 1 Vol. (1923) Tokyo, 2+5+107, with fig. and tables.]—Comparisons, the author states, of rule requirements of all the registration societies impressed him with their basic similarity, and it occurred to him that a composite set of rule requirements which is derived from the foregoing and other kindred sources might, if judiciously prepared, constitute ship requirements that may be worth offering to the ship registration societies of the world. The adoption of this common standard, would, the author believes, make for economy and simplicity in the shipbuilding art. The work is divided into seven chapters. Chapter I, for example, is a study of the requirements of registration societies. Chapter II discusses standards of strength of hull structure. The author has developed his theme very well, and the book is worthy of careful perusal, not of course, as a treatise or a text-book on the subject, but rather as a personal thesis.

T. M.

**15. *Twenty-five Years' Development of Warships in the Imperial Japanese Navy* (Japanese). Kaizo YAMAMOTO.** [J. Jap. Soc. N. A., **32** (1923), 18-33, with pl. and tables.]

**16. *Development of Japanese Merchant Ships during the Last Twenty-five Years* (Japanese). Masayoshi TSUTSUMI.** [J. Jap. Soc. N. A., **32** (1923), 34-48, with tables.]

**17. *On the Progress of Naval Science in Japan during the Last Twenty-five Years* (Japanese). Seiichi TERANO.** [J. Jap. Soc. N. A., **32** (1923), 49-53.]

**18. *On Electric Installations on Board Ship* (Japanese). Goro YAMATAKA.** [J. Jap. Soc. N. A., **32** (1923), 54-72, with diag. and tables.]

**19. *On the Rudder Area of Merchant Ships* (Japanese). Tsunemaro TOKUDAIJI.** [J. Hanshin Club, Jap. Soc. N. A., **31** (1923), 6-12, with diag, fig. and a table.]

## AERONAUTICS (1—2).

1. *On the Distribution and Variation of Temperature in the Cylinder and Piston of an Aircraft Engine.* Toyotaro SUHARA and Naozō SATŌ. [Rep. Aeronaut. Research Inst. Tokyo Imp. Univ., I (1922), 137-170, with pl.]—The temperatures of the piston and cylinder, together with those of the circulating water and the gas in the cylinder, of a six-cylinder water cooled engine of 200 HP were measured by means of 20 thermo-couples, of which 6 were put in the cylinder wall, 11 in a piston and its rings, 2 in the circulating water and 1 in the compression space of the cylinder. The result of the experiment on various running conditions of the engine may be summarized as follows: 1. The temperatures in the piston and cylinder attain a steady state in about three minutes after starting, the change being very rapid in the first minute. 2. When the speed and power of the engine vary the temperatures of the piston and cylinder also vary with them and attain a stationary condition in about three minutes. 3. The temperature of the lower part of the cylinder is only a little higher than that of the inlet water and is not materially influenced by the temperature change of gas within the cylinder. When the engine is running at normal speed under good conditions the difference between the temperatures of the top of the cylinder barrel and of the cooling water outlet is less than about 50°C. 4. The change of temperature at the centre of the piston crown is of the order of 1/5 to 1/7 that of the gas and of 1/2 of the circulating water. 5. The highest temperature of the piston exists at the crown centre and is about 200°C. above the outlet temperature of the circulating water. The temperature of the piston shoulder is about 136°C. and that at the skirt about 30°C. higher than that of the circulating water. 6. The temperature of the piston rings is considerably lower than that of the piston collars which hold the rings. 7. There exists a considerable temperature gradient near the edge of the piston head and also along the piston barrel down to the bottom of the skirt. 8. When the spark is switched off, the temperature of the piston and cylinder fall rapidly and attain a steady state in three minutes. In case of stopping completely at least five minutes are required for the free cooling of the piston and cylinder down to the temperature of the circulating water at its outlet. Authors.

2. *On the Distribution and Variation of Temperature in the Suction and Exhaust Valves of an Aero-engine* (Japanese). Toyotaro SUHARA and Naozō SATŌ. [J. Soc. Mech. Eng. Tokyo, XXVI., 78 (1923), 1-41, with fig., pl. and tables.]

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## TECHNOLOGY OF ORDNANCE (I).

1. *Optical Instruments for War Service* (Japanese). Kōgorō YAMADA.  
[J. Ord. and Exp., XVI., 5 (1923), 279-272, with fig.]
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## ELECTRICAL ENGINEERING (1—50).

**1. General Consideration on T- and  $\pi$ -Type Artificial Electric Lines with a Proposition of a Compensated  $\pi$  Line** (Japanese). **Heiichi NUKIYAMA** and **Kinjiro OKABE**. [J.I.E.E. Japan, XLII, 413 (1922), 962-973, with fig.]—

A theory of a general artificial electric line circuit, including T-line and  $\pi$ -line as its special case, is given. This theory is utilized to determine a simple method of design of a compensated  $\pi$ -type artificial electric line whose electrical characteristics can be more closely approximated to the actual uniform line than a common T-line or  $\pi$ -line, when the artificial line is required to work, not at a definite frequency, but in a definite range of frequencies. Authors.

**2. Operation and Maintenance of the 115 K.V. Transmission Line** (Japanese). **Heiji TACHIKAWA** and **Yasuke ANZO**. [J.I.E.E. Japan, XLIII, 414 (1923), 5-32, with fig.]—The authors, describe some notable results of seven years' operation and maintenance of their company's transmission line. The line, which is double circuit, 115 K.V., 140 miles in length, is the pioneer of high voltage and long distance transmission in Japan.

In regard to line troubles, a complete table is given in which they are classified according to their causes. Insulator failure is the predominant cause of line troubles.

Investigations were also conducted of the results of lightning observations made at different points of the line, and the operating record of the lightning arrester.

In conclusion a description is given of the expense of every detail of line maintenance. The total maintenance cost averages nearly \$600 per mile year or one tenth of a cent per KW.H. M. H.

**3. On Thomson's Method for the Measurement of Galvanometer Resistance** (Japanese). **Matsujiro OYAMA**. [J.I.E.E. Japan, XLIII, 414 (1923), 33-41, with fig.]—The author treats of the sensitiveness of Thomson's method for the measurement of galvanometer resistance. He concludes that the best condition can be obtained when

(a)  $Q:S$  is as small as possible,

(b)  $P:Q$  is as large as possible,

the resistance of the battery circuit being independent of the sensitiveness.

Author.

**4. On the Delineation of Wave Forms of Radio-Frequency Currents** (Japanese). **Yasushi WATANABE**. [J.I.E.E. Japan, XLIII, 413 (1923), 42-56, with fig.]—The writer proposes a new method of delineating the wave forms of radio-frequency currents in an oscillation circuit by means of a Braun tube oscillograph.

The method of wave form analysis, called "cyclic current diagram," originally proposed by Prof. H. Yagi in 1916, is insufficient for exact delineation, particularly for the interval when no current variation takes place. The new method, proposed and called "integral current diagram" by the writer, which is obtained by the combined actions of current and the terminal voltage of the condenser, is very exact and when the capacity of the condenser is known, one can determine exactly not only the wave



form, but also the time intervals. The frequency of the current can be calculated therefrom. M. H.

**5. On the Design and Construction of Glass Condensers** (Japanese). **Sadatoshi BEKKU** and **Takao AIKAWA**. [J.I.E.E. Japan, XLIII., 414 (1923), 57-66, with fig. and pl.]-The construction of an artificial three phase power transmission line 400 kilometres long was planned by the authors to study the transmission line phenomena. To perform the special study of the phenomena of arcing ground, the operating voltage was fixed at 3,600 volts  $\bar{Y}$  or 5,200 volts between lines.

This paper describes the process of manufacture and the test data of the condensers used in the line, which are the most important part of the artificial line.

For the dielectric of the condenser, ordinary plane window glass (average thickness 0.2 cm.) free from air bubbles is used. An electrolytic copper plate 4 mils thick is used as the coating, and the whole mass of the condenser proper is impregnated with commercially pure paraffin.

All of the condensers are tested with 10,000 volts 50 cycle alternating current for one minute. When the insulation resistance between the terminals and between the coating and the case is tested with a 1,000 volt meggar, insulation of more than 2,000 megohms is shown.

The total number of condensers constructed was 1,010. By a measurement at 50 cycles, the values of capacity ranging from 0.01300  $\mu$ F. to 0.00950  $\mu$ F. (0.01110  $\mu$ F. on an average) are obtained.

The discrepancy of magnitude of the capacity is presented in the form of the probability curve.

Puncture voltage tested for the glass plate was made upon 10 specimens using the electrode of circular disc of 3 cm., in dia and 1 cm. in thickness.

The results of the measurement are: maximum value 58,090 volts, minimum 34,600 volts and average 43,800 volts.

After the completion of the foregoing test, two of the condensers, when tested under 50 cycles alternating current pressure, gave puncture voltages of 32,000 and 26,000 volts. Authors.

**6. On the Frequency Doubler** (Japanese). **Yasushi WATANABE**. [J.I.E.E. Japan, XLIII., 415 (1923), 97-112, with fig.]-The writer shows that Zemack's method of doubling the frequency by means of rectifiers can be greatly improved by means of D.C. magnetization applied in the opposite direction to the magnetization of the rectified current. He also deals experimentally with the direct method of deriving alternating currents of higher harmonics from a sinusoidal current source. The experiments were made at 50 cycles per second. M. H.

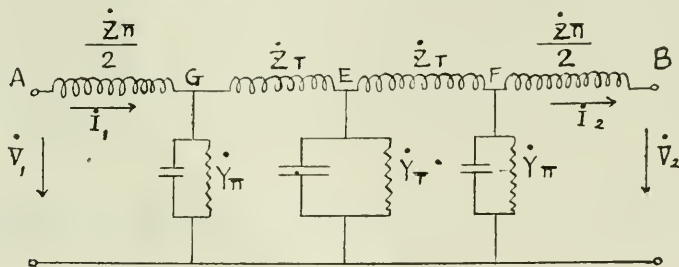
**7. Measurement of Acoustic Constants of Cloth.** **Kanesaburo KUROKAWA**. [J.I.E.E. Japan, XLIII., 415 (1923), 113-141, with fig.]-The writer accentuates the existence of the acoustic surge impedance or its density as defined by the complex ratio of pressure and velocity waves of sound through cloth or similar materials when both intensities are expressed in plane vectors and that of the common attenuation constant in complex numbers for each wave.

A technique to measure these two constants is offered. The method is to measure the motional impedance of a telephone receiver coupled with an acoustic tube, while the

latter contains a sample of cloth or similar materials to be tested, as a sound screen somewhere in the tube. For a given frequency, three measurements under different conditions of the tube are necessary to determine the two acoustic constants of the sample material when the receiver constants are known.

To show the usefulness of these constants, from data thus obtained for a woolen cloth, propagation velocity of sound, reflection and transmission coefficients of pressure and velocity waves are calculated. In addition, a steady acoustic field—pressure and velocity waves as well as power relations—near a semi-infinite screen and one of finite thickness is also discussed with numerical values for the woolen cloth. Author.

**8. On the Theory of the Combined  $T\pi$ -Type Artificial Electric Lines** (Japanese). **Heiichi NUKIYAMA** and **Yōji SHŌJI**. [J.I.E.E. Japan, XLIII., 415 (1923), 142-146, with fig.]—The T-section and  $\pi$ -section of an artificial line may be combined in series in order to make the frequency characteristics of the artificial line close to that of a uniform line to be represented. This combined  $T\pi$ -type artificial electric line which has been proposed by the present authors (Journal of the Institute of Electrical Engineers of Japan, June, 1922) is a composite line in which the T-sections and  $\pi$ -sections have different values of surge impedance. In the present paper the combined  $T\pi$ -line is theoretically treated as a homogeneous line by suitably combining the neighbouring T- and  $\pi$ -section together as shown in the figure.



Authors.

**9. On the Synchronizing Torque of the Ljungstrom Turbo-Generator Set** (Japanese). **Tōta KOMARU**. [J.I.E.E. Japan, XLIII., 416 (1923), 195-226, with fig.]—The writer studies the relation between the critical slip as a synchronous machine, and the final speed as a synchronous induction machine, of the Ljungstrom turbo-generator, with an example of an actual machine of this type, manufactured by the Mitsubishi Electric Engineering Company. M. II.

**10. On the Starting of a Three Phase Induction Motor with Cage Rotor** (Japanese). **Toshi HASEGAWA**. [J.I.E.E. Japan, XLIII., 416 (1923), 227-239, with fig.]—Classifications and tabulations of the problems of increasing the starting torque, or of suppressing the heavy starting current, of the three phase induction motor with squirrel cage rotor, are given with brief discussions of each of them; explanations of their special characteristics for commercial uses are also given. Special investigation on double cage rotors, are made, calling attention to their utilization on the range of induc-

tion motor drives. Finally, the future developments of these types of motors are suggested with a discussion of character influenced by the material of the end ring.

M. H.

**11. *On a Graphical Method for Starting Apparatus Design* (Japanese). Shinichi OGAWA.** [J.I.E.E. Japan, XLIII., 416 (1923), 240-253, with fig.]—The author describes one simple graphical method of determining the proper time elements on the design of D.C. shunt and series motor starter and starting compensator. M. H.

**12. *On the Ambiguity of the Spark Discharge* (Japanese). Yasujiro NIWA.** [J.I.E.E. Japan, XLIII., 416 (1923), 262-265, with fig.]—In the paper "Some Researches on Impulse Voltage" (J.I.E.E. Japan, 42, 1922 pp. 263-293), Bekku and Tanno have shown that that sphere gap sometimes discharges and sometimes fails to discharge even with the same condition of impulse circuits. The authors called this phenomena "the ambiguity of the spark discharge."

The present writer, suggesting that the phenomena may be explained by the casual ions in the air, attributes one of the causes of it to the position of the casual ions, and another to the sweeping effect on the ions exercised by the electrode potential.

The non-existence of the ambiguity in the needle gap may be explained by fore-running corona formation in that type.

It is also suggested that the ambiguity will be less and finally vanish as the gap length or the density of the casual ions increases. M. H.

**13. *Lightning Arrester from a Certain Point of View* (Japanese). Hidesugu YAGI.** [J.I.E.E. Japan, XLIII., 417 (1923), 279-299, with fig.]—It is often stated that an ideal lightning arrester should quickly relieve the system of excess voltages, but should not allow any flow of the dynamic current of the system.

It is shown in this paper that the statement is vague and unscientific, and that it is almost impossible to design a truly ideal arrester on the principle of a discharger.

After discussing the series resistance of a horn arrester, the superiority of a multi-gap type is demonstrated. A formula is derived which gives the magnitude of the series resistance required for a given number of air gaps.

The shunt resistance is then determined that would make the arc unstable. The discharge characteristic of an aluminium cell arrester is also considered. It is shown that the volt-ampere characteristic, which simply gives the relation between effective values, is entirely inadequate to cope with the discharge phenomena, which generally contain complicated and abrupt changes of instantaneous values.

In order to understand the instantaneous phenomena, the author states that the dynamic characteristics must be considered. But the dynamic characteristic is indeterminate unless the form and the magnitude of the lightning disturbance are given.

It is especially difficult to discuss the discharge of an aluminium cell lightning arrester since its dynamic characteristic has as yet been very little studied.

Referring to the following three cases, it is shown that, even if the arrester behaves so well as to satisfy perfectly the generally accepted conditions, the useful A.C. is apt to be discharged while the disturbing forms of potential are retained in the line, so that the step out of synchronous machines becomes inevitable.

- i. When the lightning is a high-frequency oscillation of short duration.
- ii. When the lightning is a high-frequency sustained oscillation.

iii. When the lightning is a low frequency or a static potential.

The possibility of utilizing the static capacity of the cell arrester as a high frequency absorber is pointed out. The author proposes for this purpose the use of a shorter air gap with series resistance and also a static condenser in parallel with the simple air gap hitherto employed.

Author.

**14. Commutation in D.C. Machines.** Masuho TERADA. [J.I.E.E. Japan, XLIII., 417 (1923), 300-323, with fig.]—The author studies analytically the uncompensated e.m.f. due to the pulsation of the induced e.m.f. and the compensating e.m.f. in the interpole commutation of the d.c. machines, and suggests the importance of the proper design of slot, armature winding and air gap length.

M. H.

**15. On the Oscillations Produced by means of a Tungsten Rectifier** (Japanese). Yasushi WATANABE. [J.I.E.E. Japan, XLIII., 417 (1923), 364-372, with fig.]—This paper is a supplementary note to the paper, "On the characteristics of the arc of tungsten rectifier" published (J.I.E.E. Japan, 42, 1922, pp. 745-753) by the same author.

Oscillographic studies of the oscillating currents produced by means of a tungsten rectifier were performed, namely on a direct current arc and a rectifying arc. The relation between the oscillation and the heating condition of the filament, which forms the cathode of the arc, is discussed.

The reason that such an intermittent current is produced may be explained from the dynamic characteristic curve of the oscillating arc, which can be constructed from the wave form of the intermittent current in the condenser circuit.

Author.

**16. Electric Oscillation in Transmission Lines** (Japanese). Noboru MARUMO. [J.I.E.E. Japan, XLIII., 418 (1923), 389-416, with fig.]—The writer deduces the resonance frequency from the general equation for an aerial circuit, consisting of parallel lines of uniformly distributed capacity and inductance, connected at its end to the networks of concentrated inductance and capacity. Neglecting the resistance, the distribution of current and potential along the resonant transmission line is discussed. In the experiment conducted by the writer on parallel aerial lines 538 meters long, the writer obtained the resonant wave length and found that the stationary wave is produced in the aerial line by the impressed undamped current of the resonant wave length.

Author.

**17. On Impulse Voltage** (Japanese). Motoo ÔTANI. [J.I.E.E. Japan, XLIII., 418 (1923), 442-457, with fig.]—The form and magnitude of impulse voltage and currents are studied by means of a cathode ray oscillograph, so that errors due to the inertia of the moving parts may be obviated.

The impulse generator is of the type in which a D.C. is switched on to the primary winding of a step up transformer, and a transient high voltage is induced in its secondary. The make and break of the D.C. are repeated by the use of a mercury turbine interrupter.

As the effect of the distributed capacities of the transformer windings, free oscillations of remarkable magnitude become superimposed upon the logarithmic transients such as are generally expected from simple theories. Hence the peak value of voltage



is far different from and much higher than those calculated by Steinmetz and others. The oscillation is so rapid that it seems likely that the ordinary oscillographs of electromagnetic or static type would fail accurately to reproduce the phenomena.

When condensers are connected across the secondary terminals, the free oscillations undergo marked interesting changes.

It is finally pointed out that there are considerable difficulties in applying the cathode ray oscillograph to the measurements of extra high voltages. Author.

**18. A Study on Economical Design of Extra High-Tension Transmission Lines** (Japanese). **Mitsutoshi SUZUKI**. [J.I.E.E. Japan, XLIII., 419 (1923), 481-521, with fig.]—First, the relations existing between several items, namely tower height and weight, tower weight and span, tower weight and conductor size, tower weight and line voltage, etc. are discussed. Then the study is extended to the economical design of transmission lines, giving formulae for the calculation of economical conductor size, economical transmission voltage and economical span.

Also, an analysis is made of the estimation of the installation cost of transmission lines. Author.

**19. On the Measurement of the Complex Permeability of Iron** (Japanese). **Heiichi NUKIYAMA** and **Yōji SHŌJI**. [J. I. E. E. Japan, XLIII., 419 (1923), 546-579, with fig.]—The ratio of the complex effective value of the harmonics of alternating magnetic induction and magnetic force is defined as the complex permeability. The ratio of the complex effective value of the fundamental wave of magnetic induction and magnetic force is named as the fundamental complex permeability. The method determining the fundamental ellipse of the B-H curve from the value of the complex permeability is given.

If  $S$  is the area of the ellipse determined by the magnetic force

$$h = \sqrt{2} H \cos(\omega t + \theta)$$

and the magnetic induction

$$b = \sqrt{2} B \cos(\omega t + \theta - \phi)$$

then

$$S = 2\pi HB \sin \phi$$

this ellipse is called the real ellipse. If  $S'$  is the area of the ellipse determined by the magnetic force

$$h = \sqrt{2} H \cos(\omega t + \theta)$$

and the magnetic induction

$$b = \sqrt{2} B \cos\left\{\omega t + \theta - \left(\phi + \frac{\pi}{2}\right)\right\}$$

then

$$S' = 2\pi HB \cos \phi$$

this ellipse is called the imaginary ellipse. The density of the vector power loss in the alternating magnetic field of the frequency  $f$  cycles per sec. is given as,

$$\dot{P}_b = \frac{f}{4\pi} (S + jS')$$

The writers propose to determine the complex permeability by measuring the

impedance of the magnetizing coil arranged similarly to Epstein's apparatus when there is no iron core and when there is an iron core in the sample to be tested. If  $R_i$ ,  $L_i$  are the resistance and self-inductance with iron core;  $R_o$ ,  $L_o$  the resistance and self-inductance without the iron core in a practical unit,  $l$  the length of the magnetic circuit in cm.,  $N$  the number of turns, and  $A$  the cross-sectional area of the core in sq. cm., then the complex permeability of the core is

$$\dot{\mu} = 1 + \left\{ (L_i - L_o) - j \frac{R_i - R_o}{\omega} \right\} \frac{l}{4\pi N^2 A} \times 10^9 \quad \text{[E. M. U.]}$$

The actual result obtained by this method in the audio-frequency range relating to the sheet iron for telephone and amplifier use is compared with the static hysteresis loop obtained by the ordinary magnetometer method.

Authors.

**20. Temperature Rise of Electrical Machinery, and Comparison between Single and Double Ratings** (Japanese). **Jutaro TAKEUCHI**. [J.I.E. Japan, XLIII., 420 (1923), 617-637, with fig.]—The essential part of the author's study is on the relation between the efficiency and temperature rise of electrical machines, the conclusion obtained therefrom being that the efficiency of the machine does not depend upon the temperature rise by which the machine should be rated.

The author proposes a simple method, by which one can calculate the relation between temperature rise and capacity of the machine.

The author states that the single rating is much more preferable than the double rating in all respects.

M. H.

**21. On the Jumping Phenomena in Ferro-Resonance** (Japanese). **Yasusi WATANABE**. [J.I.E. Japan, XLIII., 420 (1923), 638-652, with fig.]—The author describes the results of experimental studies on the following points: (a) the effect of resistance on the ferro-resonance, (b) characteristic curves of jumping points depending on the circuit constants, (c) jumping phenomena caused by the variation of resistance under constant impressed voltage, (d) observations of the jumping phenomena by means of the Braun tube oscillograph. Expressing the relation between the square of the impressed voltage and the square of the current by an algebraical equation of the third degree, the author explains certain phenomena with regard to the jumping of the resonance current. He also proposes a new method of graphically representing the jumping phenomena.

Author.

**22. On the Grounding LC Reactor** (Japanese). **Yasusi WATANABE**. [J.I.E. Japan, XLIII., 420 (1923), 653-660, with fig.]—The author proposes a new method of grounding the neutral of a transmission system, namely the use of a condenser in conjunction with a grounding reactor.

"The grounding LC reactor," as the author suggests calling it, is either of the following:

- (a) An iron-core inductance coil with a condenser connected in parallel, or
- (b) An iron-core coil put in series with a resistance, and then connected in parallel with a condenser.

The advantage of the LC reactor lies in the fact that a reactor with a slightly saturated core may be safely employed so as to compensate exactly for the capacity

current, without causing any appreciable wave distortion, so that the quenching action is ideally effective.

The danger of the so-called series resonance, which is the most serious drawback of Petersen's resonance coil, may be avoided by the use of the LC reactor; for the combination behaves, with regard to the series resonance, just like a single reactance coil with a highly saturated core and a high series resistance.

The underlying principle of this new form of grounding reactor is explained by graphical methods, and some experimental results are described relating to the LC reactor.

Author.

**23. On the Design of Resonance Reactors** (Japanese). **Shinji TOGO**. [J.I.E.E. Japan, XLIII., 420 (1923), 661-668, with fig.]—

1. Equilibrium points in resonance.

Corresponding to a given E.M.F. and a given capacity, a resonance curve or a curve of current for varying inductance may be plotted. On the other hand, the variation of inductance of an iron cored reactor with varying magnetizing current may be represented by a substitution curve. The equilibrium conditions can be ascertained as the intersecting points of these two curves.

2. Elementary reactor.

For the study and design of a resonance reactor, it is convenient to consider an elementary reactor, i.e. a reactor with unit volume of iron core and a single turn of winding around it.

3. Protection against the series resonance.

In order to protect against the danger of the so-called series resonance, it is advisable to design a reactor for a high flux density; the use of a certain amount of series resistance will also be advantageous.

Author.

**24. Absorption of Moisture by Fibrous Insulating Materials** (Japanese). **Yotsuo TORIYAMA**. [J.I.E.E. Japan, XLIII., 420 (1923), 677-693, with fig.]—The writer studied the absorption of moisture by various fibrous insulating materials. At first, the sample is dried for several days by placing it in a hygostat containing concentrated sulphuric acid, and its weight is measured; then the acid is diluted step by step to obtain several relative humidities up to 95%. The relation between the absorption of moisture and relative humidity is expressed in the following formula which is concordant with observed values for a range of zero to 95 per cent. of relative humidity.

$$Q = \frac{1}{\frac{a}{H} + b - cH}$$

where  $Q$  = moisture absorbed in percentage.

$H$  = relative humidity in percentage.

$a, b, c$  = constants depending upon insulating materials.

The absorption of moisture by fibrous insulating materials depends on the mode of variation of humidity. A considerable difference is observed in the quantity of moisture absorbed, whether the humidity varies from dry to wet or wet to dry. That is, there are hysteresis phenomena in the absorption of moisture by fibrous materials. All of the above experiments are conducted in a thermostat of constant temperature of 30 degrees C.

In order to ascertain the effect of temperature rise on the absorption of moisture the concentration of the sulphuric acid in the vessel is kept at a constant value and the temperature of the surroundings of the vessel varied, and the change in the weight of the sample is observed. The weight of the sample does not change much, but decreases very little with temperature rise.

Also by utilizing the phenomena of temperature rise of a sample caused by the absorption of moisture, the writer compared the absorption of moisture by various samples in vacuum. This method does not give accurate absolute value of the absorption of moisture, but is convenient for comparing many samples in a short time.

Author.

**25. General Equations of Alternating Current Bridges** (Japanese). **Seikichi JIMBO**. [J.I.E.E. Japan, XLIII., 420 (1923), 694-700, with fig.]—The author has shown that a general equation of the representative a.c. bridge can be readily derived by algebraic methods, applying the general theory of a d.c. network. The equation is shown to be more general than that given by Prof. Katapetoff. Some practical applications of the equation are given.

Author.

**26. Effect of Humidity on the Electrical Resistance of Fibrous Insulating Materials** (Japanese). **Takeo AKAHIRA**. [J.I.E.E. Japan, XLIII., 421 (1923), 719-746, with fig.]—The effect of humidity on the insulation resistance of some commercial fibrous insulating materials was investigated. To avoid experimental errors due to inconstancy of other conditions, the influence of temperature, applied voltage etc. was also studied.

It is shown in this paper that, after the voltage is applied to the sample, the charging effect occurs, the temperature rises, and the distribution of absorbed moisture changes, owing to the leakage current through the material; therefore, the resistance at a given condition should be computed by obtaining the leakage current at the initial instant the e.m.f. is applied to the material. It is stated that in general the humidity has a very profound influence on the insulation resistance of fibrous materials, and the relation between insulation resistance and relative humidity, which varies in a cyclic manner, represents a hysteresis loop due to the hygroscopic hysteresis property of the fibrous material. Hence the resistance at a certain humidity should be expressed with the record of previous changes of humidity. For practical purposes, however, it is convenient to express the insulation resistance at a specified humidity with the average value of resistance corresponding to that humidity obtained from the hysteresis curve of resistance against humidity. It is recommended that the relation between such average resistance and humidity should be expressed by an empirical formula

$$\log_{10} R = a - \frac{bh}{1 - ch^2},$$

where  $R$  is the average resistance for relative humidity  $h$ ,  $a$  a constant depending on the insulation resistance of the material itself at zero humidity, and  $b$  and  $c$  are constants expressing the effect of humidity on the resistance. For eleven materials, these constants are obtained by experimental results; and it is shown that they are very nearly equal for materials of vegetable origin, but they differ considerably for materials of animal and mineral origin and for treated materials. Finally it is stated that the effect of humidity on the insulation resistance of such materials may be



determined by measuring average resistances corresponding to three different humidities and computing constants by the above formula. Author.

**27. On Arc Hysteresis Curves** (Japanese). **Hidetsugu YAGI** and **Seitaro MURAI**. [J.I.E.E. Japan, XLIII, 421 (1923), 750-758, with fig.]—Apart from the fact that the dynamic characteristic of a discharge changes its shape according to the nature and the wave form of the electrical phenomenon, it is not inherently characteristic to the discharge itself, but is also affected by the nature of the entire circuit.

As an illustration, a carbon arc is lit by a 60 cycle 300 volt alternating current source, and arc hysteresis curve is observed by means of a Braun tube oscillograph.

The mode of deformation of the curve for varied arc lengths shows that the arc hysteresis may be considered to have two origins, one being the energy consumption for the ionization at and near the electrodes, and the other the electric and kinetic energy storage by the ions in the arc flame portion.

The arc hysteresis curves are reproduced, when the series impedance is a non-inductive resistance, or an inductive reactance. The result for constant arc length, constant voltage (effective value) and constant arc current (effective value) but with the impedance gradually varying from non-inductive to highly inductive, is most instructive.

Besides the well known fact that a non-inductive steadying resistance for an A. C. arc spoils the efficiency and an inductive steadying reactance lowers the power factor, the effect of the arc length and the nature of the series impedance should also be taken into consideration and must be properly selected according to the purpose of the practical application of the arc discharge. Authors.

**28. On the Thermo-converter** (Japanese). **Hideo NUMAKURA**. [J.I.E.E. Japan, XLIII, 421 (1923), 759-767, with fig.]—The writer describes the method of construction and some characters of the thermo-converter which is used to measure milliamperes of alternating current. M. H.

**29. On the Instantaneous Phenomena of D.C. Electromagnets** (Japanese). **Yotsuo TORIYAMA**. [J.I.E.E. Japan, XLIII, 421 (1923), 768-775, with fig.]—The author calculates the penetration of flux into a D.C. electromagnet under the assumption that the electromagnet is an infinitely long solid cylinder.

First he assumes that the excitation occurs instantly, and compares his result with the experimental result obtained by Dr. Hopkinson. He ascertains that both results agree approximately with each other.

Secondly he treats of the penetration of flux into an iron core when a constant e.m.f. is applied to the exciting circuit of the electromagnet. Author.

**30. The Design of the Noguchi Transformer as an Audio-frequency Source for a Kohlrausch-Bridge** (Japanese). **Koju NOGUCHI**. [J.I.E.E. Japan, XLIII, 421 (1923), 776-789, with fig.]—The Noguchi transformer is a special transformer designed by the author for the purpose of producing audio-frequency alternating current for the use of the Kohlrausch bridges and for other similar purpose. This apparatus consists of a filament incandescent lamp and a small transformer in series. The core of the latter has a re-entrant for about 1/10th of the total length; around the re-entrant the sectional area of the core is made about 1/4th of the

remaining part. Applying the ordinary A.C. town voltage to the primary of this transformer, one can obtain a narrow, steep and peaked voltage from the secondary side, due to very high magnetic saturation in the narrow portion of the core. This peaked voltage excites the telephone receiver of the Kohlrausch bridge so that it gives an audible sound having the natural frequency of the receiver. With the use of this audio-frequency source the measurement may, without difficulty, have an accuracy of 1/10,000.

The author deals with the theory of obtaining the peaked voltage, and shows the process for designing the transformer to give the best result. The theoretical deductions are confirmed by oscillograms. Author.

**31. What are the Non-arcing Metals?** (Japanese). **Hidetsugu YAGI** and **Heizaburo OYAMA**. [J.I.E.E. Japan, XLIII., 422-3 (1923), 809-819, with fig.]—In 1892, A. J. Wurtz published his discovery of non-arcing metals. In this paper it is intended to ascertain whether such metals really exist, and if so, what the true nature of this quality is.

In Tôhoku Imperial University, M. Nakajima made studies of D.C. characteristics and A.C. Volt-Ampere characteristics of various metal arcs placed in air or in coal gas atmosphere. Cu and Zn were taken as representative of arcing and non-arcing metals respectively, and it was ascertained that, for small currents, there are certain differences in qualities between Cu-arcs and Zn-arcs. For larger currents, however, the non-arcing metals discovered by Wurtz are very likely not the metals for which the arc is difficult to start; on the contrary, they are the metals which can maintain the arc with ease and stability.

The writers made an oscillographic study of instantaneous phenomena, and ascertained the existence of two distinctly different phases of discharge between copper electrodes.

All the above mentioned studies are still inadequate to give a clear explanation of the non-arcing quality of metals. It is stated that the problem needs to be attacked from other directions, and several factors are enumerated which seem to have a connection with this special quality of certain metals. Authors.

**32. On the Time-lag of Voltage Building-up of Self-excited D. C. Generator** (Japanese). **Yasushi WATANABE**. [J.I.E.E. XLIII., 422-3 (1923), 830-840, with fig.]—The author treats of the build-up phenomenon of voltage of a self-excited D.C. generator.

A simple formula is deduced which represents the relation of the time required by the generator to build up to the electrical constants of the field circuit, residual magnetism and the saturation effect.

The time-lag increases with the resistance of the field circuit up to a certain point, beyond which the lag again decreases.

Some remarks are made on the theoretical studies of the problem comparing them with experimental facts.

It is experimentally ascertained that, with low residual magnetization, the time-lag is much larger than that theoretically estimated.

This discrepancy is attributed to the creeping phenomenon of the current. The E. M.F. that causes the increase of the current is to be determined by the difference between the ordinates of the saturation curve and a straight line representing the voltage drop in the resistance of the field circuit. Since the saturation curve has

virtually a point of inflexion, the rate of increase of the current may become very slow, entailing a considerable time-lag. Author.

**33. On the Voltage Amplification Ratio of the Triode Valve Resistance Amplifier** (Japanese). **Heiichi NUKIYAMA** and **Toshita KUWA-SHIMA**. [J.I.E.E. Japan, XLIII., 424 (1923), 859-869, with fig.]-The voltage amplification ratio of the triode valve resistance amplifier is measured in the audio-frequency range by means of an alternating current potentiometer. As the source of the alternating current, a triode valve oscillator is used.

The relation between the amplification ratio and the resistance in the plate circuit and the amplitude of the impressed alternating voltage at the grid, is studied experimentally. It is observed that, in the amplifier which has a grid condenser, the grid average voltage is affected to a great extent by the input grid alternating potential due to the rectifying action and this will cause the change of the amplification ratio by the change of the amplitude of the input grid alternating potential.

From the static characteristics with the resistance in the plate circuit, which is called the resistance static characteristics, all the dynamical phenomena are explained. Authors.

**34. Circle Diagram of Polyphase Induction Motors** (Japanese). **Hidetaro HO**. [J.I.E.E. Japan, XLIII., 424 (1923), 870-875, with fig.]-It is shown that the exact circle diagram of polyphase induction motors can be derived in a simple and easy manner, without using inversion and other troublesome processes, by applying the principle of superposition of currents. Author.

**35. On the Generation of an Extra-Low-Frequency E. M. F., and the Measurements of Mechanical Constants of Electrical Meters** (Japanese). **Yasusi WATANABE**. [J.I.E.E. Japan, XLIII., 424 (1923), 876-892, with fig.]-Alternating E.M.F. at extra-low-frequency, say from a fraction of a cycle to several cycles per second, can be derived from a separately excited D.C. generator, when the brushes are slowly revolved around the commutator by some mechanical means. The frequency is given by the number of revolutions per second of the brushes multiplied by the number of pairs of poles of the generator. The magnitude of the E.M.F. may be varied by the field excitation.

One of the various applications of the extra-low-frequency E.M.F. is the determination of mechanical constants of electrical measuring instruments. The method is based on the fact that the amplitude characteristic of the forced vibration of the moving system reveals resonance for certain frequencies of the impressed E.M.F.

Test results are given for the instruments of the moving coil type, the moving iron type, the electro-dynamometer type and the hot-wire type.

It is ascertained that measuring instruments for industrial use generally have natural frequencies less than two to three cycles per second, and that many of them have small value of bluntness, i.e., insufficient damping effect.

Hysteresis phenomena are observed for instruments of permanent magnet type, and even jumping phenomena for those with very small bluntness. Author.

**36. Design, Construction and Preliminary Test of the Three Phase Artificial Transmission Line** (Japanese). **Sadatoshiki BEKKU**. [J.I.E.E.

Japan, LXIII, 424 (1923), 893-913, with fig.]—The detail of the artificial three phase transmission line built at the Electrotechnical Laboratory, Tokio, is fully described in this paper. The electrostatic and electromagnetic requirements to represent the three phase transmission line are discussed.

The whole line consists of one hundred  $\pi$ -section. The equivalent length is measured to be 517.1 kilometers, and it can be used as two parallel lines of length 256.5 kilometers and 258.6 kilometers. The line is capable of working at 5,200 volts continuously at 50 cycles. With slight modifications of the connections, the artificial line can represent other lines of different constants.

From the measured values of the line constants, the propagation constants are worked out and agree well with the actual measurements. M. H.

**37. On the Electrostatic Disturbance of Aerial Lines** (Japanese). **Fumio SHIN.** [J.I.E.E. Japan, XLIII, 424 (1923), 914-918, with fig.]—With the intention of ascertaining whether the electrostatic disturbances of aerial lines can be anticipated from the change of capacities between lines or not, the writer has made special investigations both theoretically and experimentally.

The capacities between lines have been measured by means of counting the beats produced in radio-oscillators, the result of which coincides fairly well with that obtained theoretically. Author.

**38. Magnetic Properties of Sheet Steel under Superimposed Alternating Field and Unsymmetrical Hysteresis Losses.** **Yasujiro NIWA** and **Yoshihiro ASAMI.** [Researches, Electrot. Lab. Tokio, Japan, 124 (1923), 1-25, with fig. and pl.]—The authors studied the properties of unsymmetrical hysteresis losses dynamically operated, superposing an alternating field upon a d.c. field.

As one of the means of minimizing the eddy current effects a sample of very thin sheet was used.

First, the magnetic properties of the sample under superimposed alternating field were studied and it was found that the saturation curves as well as the hysteresis loops are considerably affected by the superimposition.

Next, taking these effects into consideration, the properties of unsymmetrical hysteresis losses traced by the superimposed a.c. were studied.

The results are shown by numerous loops and curves. Some general conclusions and an experimental formula are given within the range of this experiment.

Authors.

**39. On the Calculation of Self Inductance of Coils Wound in Square Forms.** **Yasujiro NIWA.** [Researches, Electrot. Lab. Tokio, Japan, 126 (1923), 1-19, with fig.]—1. In the former paper (Researches of Electrotechnical Lab., No. 73, 1918.) the author treated of the solenoid with rectangular section and derived a formula for the calculation of the self inductance of such a solenoid. In the present paper the author discusses the range of application in which the formula can be used with allowable error.

2. Dr. Esau's criterion on the applicability of the author's formula (Jahrb. F. Drahtl. Telegraphie Dec. 1921) is reviewed and it is shown that Esau's conclusion must be modified owing to his calculation of the correction factors.

3. From experiments as well as calculation it is shown that the author's formula



may be applied with accuracy for all coils however flat they may be, with the ratio of the pitch to the diameter of the wire  $\left(\frac{g}{2\phi}\right)$  less than 6 or 7, and also that even for coils with this ratio so large as 20 or 30 the formula may be applied with a small percentage of error for moderate values of the ratio of the side of section to the length of coil ( $\phi$ ) such as 40 or 50. It is also shown that the range of  $\phi$ , applicable with a certain percentage of error, becomes limited as the ratio  $\frac{g}{2\phi}$  increases.

4. A formula for the self inductance of a solenoid with similar concentrated windings at equal intervals is also given. Author.

**40. The Relation between Life and Impressed Voltage of 100 Volt, 10 Candle Power Incandescent Vacuum Tungsten Lamps** (Japanese). **Masaiye HORIOKA** and **Gentei YAMAZAKI**. [Researches, Electrot. Lab. Tokio, Japan, **128** (1923), 1-20, with fig.]-In this paper the relation between life and impressed voltage of 100 volt, 10 candle power incandescent vacuum tungsten lamps was mainly studied with the life-candle power, life-efficiency and life-filament resistance relations.

About two thousands lamps made by two principal lamp makers were subjected to this test.

The results show that the well known life-voltage relation,  $LV^x = \text{const.}$ , cannot be applied to these lamps; that is, the logarithms of life and voltage have not a straight line relation, but their relation must be regarded as a branch of hyperbola.

If this form of life-voltage relation be adopted, the index number 14 now commonly in use should be changed to 11 to 12.

The equations proposed by the authors:

$$\left(\frac{L}{b}\right)^{\frac{1}{\sqrt{a^2 + \left(\log_{10} \frac{V}{100}\right)^2}}} = C,$$

and 
$$L_0 = b \left(\frac{L}{b}\right)^{\frac{a}{\log_{10} \frac{V}{V_0}}},$$

exactly coincide with the experimental curves and by the use of this latter relation the accurate hours-life at normal voltage can be derived from the measured life under any voltage between 130 and 150 volts. The value of  $a$  is about 0.02 for both lamps and  $b$  varies between 2,000 and 3,700, of which the higher limit may be used for carefully manufactured lamps. Authors.

**41. On the Method for Estimation of Sulphur in Steel Wire for Electrical Use.** **Eishiro IMUDA**. [Researches, Electrot. Lab. Tokio, Japan, **130** (1923), 1-12.]-Several methods for the estimation of sulphur in steel wire for telephone and telegraph use were compared and the volumetric method of H. H. Willard and W. E. Cake is recommended. A new type of apparatus for estimation of sulphur is designed by the author. Author.

**42. Study on the Conductors of Continuous Loaded Cable.** Teijiro HORIE and Kenichiro DAN. [Researches, Electrot. Lab. Tokio, Japan, 131 (1923), 1-40.]—This research deals with the electrical characteristics of the various kinds of continuous loaded conductor with a view to investigating the best construction for a given frequency range. The authors prepared various conductors about twenty feet long, which consisted of B.S. # 14 copper wire wound by fine iron wire of various diameters from 0.2 to 0.5 mm. Also the authors constructed a measuring set capable of detecting a very feeble current and measured the following points: (a) variation of effective resistance and inductance with telephonic frequencies, covering the range from 200 to 3,000 cycles; (b) variation of effective resistance with the magnitude of measuring current; (c) variation of effective resistance and inductance caused by superimposition of direct current; (d) variation of effective resistance and inductance owing to the temperature rise. Authors.

**43. Colour of Electric Incandescent Lamps** (Japanese). Mitsukazu IGARI. [J. Ill. Eng. Soc. Japan, VI., 4 (1922), 338-352, with fig.]—The author gives brief sketches of the method of colour analysis, laying stress upon spectrophotometry, monochromatic analysis and trichromatic analysis, and describes his experiment on the trichromatic analysis of various electric incandescent lamps, the sun and blue sky, comparing his results with those of other authors. Finally he checked his results by the use of transmission curves of the colour filters used and the luminosity curve of these illuminants. Author.

**44. Ocular Function and Illumination** (Japanese). Kuzo SUZUKI. [J. Ill. Eng. Soc. Japan, VII., 1 (1923), 47-59, with fig.]—This paper gives the results of the experiments made at the Research Laboratory of the Tokio Electric Company on the effect of illumination upon two phases of ocular functions, visual acuity and speed of vision. Illumination is measured on the brightness basis. The results are as follows: (1) König's classical formula is found to make the results interpretable; (2) the maximum point of visual acuity is reached at the brightness of not less than 25 milliamperes; (3) as the standard field brightness for clinical tests of visual acuity, 10 milliamperes is recommended; (4) Schwarzschild's law bids fair to hold for the sensitometrical data of retina. Author.

**45. On the Physical Causes of the Blackening Phenomena of Incandescent Electric Lamps** (Japanese). Chozaburo MATSUDA. [J. Ill. Eng. Soc. Japan, VII., 2 (1923), 163-189, with fig.]—After reviewing the present status of incandescent electric lamps, the author proceeds to set forth the physical explanation of the blackening phenomena on the basis of metallographic investigations.

The author explains the blackening phenomena as due to thermal evaporation from his metallographic observations on the long burned tungsten filament, assuming the amorphous phase theory of the metal. Evaporation is more marked in the part of amorphous phase than in the crystal grains. This view is supported by the experiments. Evaporation from crystal grains seems to take place neither uniformly from all over the surface, nor along the edges of the crystals. All these facts are not in accordance with Kundsen's work that the vaporisation from crystal surfaces occurs equally well for all directions. They are also not in accordance with the general fact that the crystal development or deterioration is effected along the edges of the crystal.

The crystal surfaces show many specks irregularly situated upon them. This seems to be due to the electronic or ionic bombardment, and seems to provide one of the evidences for the disappearance of filament material caused by electrical disintegration. Disintegration does not seem to take place by grains themselves as units. On the bulb glass or on the anchors the author does not detect crystal deposits, although their temperatures are sufficiently high. This does not agree with the experiments of Tieds and Brinbrauer. The nature and appearance of the deposits differ according to experimental conditions. The author also remarks the effects of the occluded gases in the filament upon disintegration.

With sufficiently high voltage above the ionisation potential of nitrogen and with the steady supply of thermions from the incandescent filament, ionisation takes place in the lamp and the author observed the line spectra of nitrogen emitted by the ionisation of the gas, superimposed upon the continuous spectrum due to temperature radiation.

In some cases crystal grains appear on the metallic surface caused by the electronic bombardment. The author explains the phenomena by taking account of the germinative temperature of the metal and the heating effect produced by the electronic bombardment.

M. II.

**46. *On the Weight Efficiency of the Secondary Battery*** (Japanese). **Sakae MAKIO.** [J.I.E.E. Japan, XLIII., 422-423 (1923), 820-829, with fig.]

**47. *Comparison of the Characteristics and Durability of the Planté Type Secondary Batteries of Home and Foreign Make*** (Japanese). **Sakae MAKIO.** [Researches, Electrot. Lab. Tokio, Japan, 125 (1923), 1-37, with fig. and pl.]

**48. *On the Glare*** (Japanese). **Satoshi KONII.** [J. Ill. Eng. Soc. Japan, VI., 4 (1922), 353-397, with pl.]

**49. *Blackening of Incandescent Lamps and Methods of Preventing it*** (Japanese). **Kiyoshi ABE.** [J. Ill. Eng. Soc. Japan, VI., 4 (1922), 398-412, with fig.]

**50. *Application of Projectors for Interior Lighting*** (Japanese). **Fumio MINAMI.** [J. Ill. Eng. Soc. Japan, VII., 1 (1923), 42-46, with fig. and pl.]

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## ARCHITECTURE (1—2).

1. *Design of a Reinforced Concrete Round Column and Chimney Subjected to Bending Moment* (Japanese). **Tachu NAITO** and **Kiyoshi KAWAI**. [J. Inst. Jap. Architects, Ser. XXXVI., 431 (1922), 253-268, with fig.]—A method of practical calculation of a reinforced concrete round column subjected to an eccentric load or to bending moment due to lateral load caused by wind pressure or by earthquake is dealt with. The authors give diagrams from which the position of the neutral axis and a coefficient  $K$  giving the maximum concrete stress are found for a given eccentricity of load and for the various percentages of steel to the total area of concrete.

Authors.

2. *Earthquake-proof Construction of Skeleton Structures* (Japanese). **Tachu NAITO**. [J. Inst. Jap. Architects, Ser. XXXVI., 436-438 (1922), 391-418, 441-467 and 487-510; Ser. XXXVII., 439-441 (1923), 3-18, 39-53 and 69-86, with fig.]—A practical method of calculation of skeleton structures is shown in this paper. In the first part, a comparatively simple "Modified Portal Method" is proposed and it is shown that, in comparison with Wilson's exact method, the proposed one is practically accurate. The assumption in this method is a modification of the assumption made in Fleming's Portal Method. In the second part, investigation is made of the manner of distribution of lateral forces among the different frames, such as open bent, stiff bent or wall bent. The author introduces "distribution coefficient  $D$ " to determine the due share of lateral forces to be borne by these frames. The applications of this method in the design of the frame of an earthquake-proof building are shown. In the appendix, the structural design of the Takashimaya Department Store, the Osaka Steamship Co. office building, the Nippon Industrial Bank Building etc., in which the author has been concerned, is shown.

Author.

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## MINING ENGINEERING (1—9).

1. *The Specific Gravity and Ash Content of Coal* (Japanese). **Gizo SUGIMOTO**. [Monthly Rep. C. C. M. A. Japan, XIX., 230 and 231 (1923), 667-681 and 796-808, with fig. and tables.]—The relation between the specific gravity and ash content of coal is taken to be given by the formula  $R=D-KP$ , where  $R$  denotes the specific gravity of pure coal,  $D$  the specific gravity of coal,  $K$  the coefficient and  $P$  the ash content. From the results of the author's tests the average value of  $K$  for Japanese coals is determined to be 0.0056. The features of the distribution of ashes in coal are investigated by X-rays. H. Sano.

2. *Washing Tests of Nut Coal by Rheo-laveur* (Japanese). **Yōichi OKADA**. [Monthly Rep. C. C. M. A. Japan, XIX., 231 (1923), 765-769, with fig. and tables.]—A report on washing tests of nut coal by Rheo-washer. H. Sano.

3. *Washing Tests of Fine Coal by Rheo-laveur* (Japanese). **Yōichi OKADA** and **Fukusaburo YAMAMOTO**. [Monthly Rep. C. C. M. A. Japan, XIX., 232 (1923), 885-896, with tables.]—A report on washing tests of fine coal by Rheo-washer. H. Sano.

4. *Upon the Theory and Construction of Mine Fans* (Japanese). **Fumio ODA**. [Nihon-Kōgyōkwaishi, Ser. XXXIX., 455 (1923), 38-51, with fig.]—The author gives  $H=\frac{V^2}{2g}$  as an expression for the theoretical depression of mine fans, against  $H=\frac{U^2}{g}$  which was found by Daniel Murgue,  $H$  being the theoretical depression,  $V$  the velocity of outflow from the vanes in radial direction,  $U$  the velocity of the outer circumference of the wheel and  $g$  the acceleration of gravity. He has designed a standard fan in which the flow through the wheel is radial, the vanes forming logarithmic spiral curves. H. Sano.

5. *On the Separation of Ash from Coal* (Japanese). **Jitaro YONEZAWA**. [Nihon-Kōgyōkwaishi, Ser. XXXIX., 455 (1923), 52-54, with fig. and tables.]—Tests with Japanese coal to compare the results obtained by the oil flotation process with those by the Trent process are described. H. Sano.

6. *Analytical Studies upon the Ventilating Pressure in Mines* (Japanese). **Einosuke MIKUMO**. [The Suiyō-Kwaishi, IV., 4 (1923), 492-498, with fig.]—The author discusses the positions of U-tubes for measuring the ventilating pressure in mines. He explains that the method which is adopted by Heise-Herbst and Henry Briggs can be applied to ordinary cases without any appreciable error, but Peele's method is limited to the case where the fan has no chimney and air has the same velocity at both sides of the fan. H. Sano.

7. *On Oils for the Flotation Process of Ore Dressing* (Japanese). **Kojiro KAWAMURA**. [The Suiyô-Kwaishi, IV., 3 and 4 (1923), 363-383 and 427-477, with fig. and tables.]

8. *Microscopical Determination of Ore* (Japanese). **Ginjiro KURAUCHI**. [The Suiyô-Kwaishi, IV., 4 (1923), 478-491, with fig.]

9. *Fundamental Formula for Mine Ventilation* (Japanese). **Nobuhide KISHIMOTO**. [The Suiyô-Kwaishi, IV., 4 (1923), 499-534, with fig. and tables.]

## METALLURGY (1—6).

1. *Utilisation of Waste Heat in Open-Hearth Furnaces* (Japanese). **Heihachi YOSHIMURA**. [Tetsu-to-Hagane, VIII., 12 (1922), 863-866, with tables.]—The author calculated the amount of the waste heat for heating waste heat boilers utilising the gas passing from the regenerators of open-hearth furnaces to the chimney. The calculation is based upon the data obtained from a 70 ton basic open-hearth furnace which has recently been installed. He calculated first the amount and composition of the combustion products of the gas, and then showed the amount of available heat to be 480,428 cal. per ton of ingot produced which was equivalent to 167 kgs. of coal used in the producers.

2. *On the Value of the Percentage of Elongation of Tensile Test Pieces with Different Dimensions, Part I. Cast Steel* (Japanese). **Keikichi SATAKE** and **Kajima MUROI**. [Tetsu-to-Hagane, IX., 9 (1923), 687-698, with fig. and tables.]—The Japanese Engineering Standards Committee is about to adopt the test piece having a diameter of 14 mm., a gauge length of 50 mm., and a parallel part of about 60 mm. for forgings and castings of ferrous and non-ferrous metals. The present authors made an investigation of the percentages of elongation of cast steel test pieces having the standard form and those used in our naval construction department at present. Diagrams are also given showing the percentages of elongation of the new standard test piece and those of the French and German Standards. K. Muroi.

3. *Pyrometallurgy of Copper in Japan* (Japanese). **Kenzo IKEDA**. [Nihon-Kôgyôkwaishi, Ser. XXXIX., 455-460 (1923), 1-31, 94-119, 161-184, 237-270, 344-373 and 417-440, with fig., phot. and tables.]—This deals with the pyritic smelting and the basic converting processes in Japan. A great improvement in ore smelting at the Kosaka plant has been effected by means of the application of a slow pyritic smelting entirely without coke or limestone, and with a charge of over 50% of briquetted or agglomerated fines. He states that the slow pyritic smelting is really superior to the rapid process from an economical point of view, all circumstances in Japan being taken into consideration.

The furnace phenomena occurring within the pyritic furnace have been thoroughly investigated by an abrupt stopping of the active furnace under normal running. The internal state of the furnace was minutely observed.

He gives a study on slag with different contents of CaO, dividing Ferro-lime slags into four classes, and concludes that in general 8% CaO slag will result in the greatest economy so far as the copper loss is concerned, while below 5%, the copper will go up decidedly, and above 12%, the further saving of copper is hardly attainable exercising on the contrary rather a harmful effect on the smelting.

The first success in basic converting in Japan was attained by the author, and it will probably be a world's record both in life and production with a single lining of small sized vessels. It is still in active service.

Based on his practical experience, the author points out many important facts relating to the design of blast furnaces as well as basic converters, which are usefully

applicable to Japanese conditions and practice. Above all, large sized tuyeres and an ample supply of weak blast are recommended in slow pyritic smelting, while rather a thin thickness of magnesia brick lining in basic vessels is advocated. T. Miyazaki.

**4. On the Influence of Cold Rolling upon the Properties of Sheet Steel II, X-Ray Study.** Yasujiro NIWA and Jiro MATSUURA. [Researches, Electrot. Lab. Tokyo, Japan, **122** (1922), 1-20, with fig. and pl.]

1. The change in the inner structure of steel by successive cold rolling is studied by the interference method of X-ray.

2. It is shown that the results obtained in experiment may be interpreted by assuming that the crystal grains are divided by rolling stress into finer groups of cubic lattices which make sliding and rotation between adjacent planes and finally rearrange themselves in a manner so as to have the edge of the lattice in parallel to the direction of rolling. Also there is the tendency for one diagonal of the face of the lattice to lie in the plane of the sheet and perpendicular to the direction of rolling. During this change in the structure, parts of the crystal grains are crushed into extremely minute crystals which are distributed without regular order. It is suggested that the regular arrangement of the lattices as above mentioned is the result of the rolling process and a different process will cause a different regular orientation.

3. It is shown that the strain due to the cold rolling penetrates from the surface to the inside as the rolling process proceeds.

4. The interference figures of strained sheet steel annealed at several temperatures are shown. Authors.

**5. Lattice Strain Theory of Hardening of Metals.** Skezug KIMURA. [Researches, Electrot. Lab. Tokyo, Japan, **123** (1923), 1-7, with fig.]—The author points out that there has hitherto been too much tendency to explain the cause of the hardening of metals from mechanical ideas (one example of which is "the slip intereferency theory"). Against this prevailing idea he considers the origin of hardening of metals to be attributable to the interatomic forces and tries to explain it from the interatomic stress caused by the distortion of the space lattice. His view on the martensitic hardness is as follows:

When steel is cooled at a temperature higher than that corresponding to  $A_3$  transformation of iron, the configuration of the iron atoms changes from a face-centred cube to a body-centred one. This change is not the direct cause of separating cementite; the separation of cementite may be an inevitable result following on the change of the configuration of the iron atoms, the carbon and the iron atoms being unable to form a stable equilibrium in the body-centred cubic configuration. Thus, in cooling steel, the face-centred cubic configuration of iron atoms will be broken at first and the iron atoms will tend to rearrange themselves in a regular body-centred cubic configuration separating themselves from carbon atoms.

In quenching, however, this rearrangement will be hindered by the dissolved carbon atoms, and the configuration of the iron atoms in martensite must be severely strained. This may be the chief cause of the martensitic hardness. Author.

**6. The Reverberatory Furnace Smelting at Naoshima in Japan** (Japanese). Fusajiro SARADA. [Nihon-Kôgyôkwaishi, Ser. XXXVII., **454** (1922), 816-823, with diag.]



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## CIVIL ENGINEERING (1—26).

**1. On the Phase of Oscillation of Structures caused by Earthquake-motions** (Japanese). **Kenzaburō MAJIMA.** [J. Civ. Eng. Soc., X., 1 (1924), 49-77, with fig. and pl.]—Usually structures subjected to seismic vibration are considered as if they were rigid bodies. In this paper the author took the elasticity of the structures into consideration. He obtained a formula giving the period of free vibration and also found the elastic curve assumed by the axis of a body when it is subjected to a horizontal seismic movement. K. S.

**2. The Vibration of Bridges and its Relation to Impact** (Japanese). **Nagaho MONONOBE.** [J. Civ. Eng. Soc., X., 1 (1924), 79-122, with fig. and pl.]—This paper describes theoretically the relation between the free vibration of metallic bridges and periodically changing external forces due to a travelling load.

The author has worked out by the energy method new formulas available for typical railway bridges of plate-girders and trusses, which are as follows:—

$$T^2 = \frac{4\pi^2}{g} \cdot \frac{w+p}{p} \cdot \frac{p}{8E} \cdot \frac{I^4}{I_c} \cdot \frac{\int_0^l \gamma_c^2 dx}{\int_0^l \gamma_c dx} \dots\dots\dots \text{for a plate girder bridge}$$

$$T^2 = c l^2 \sqrt{\frac{w+p}{I_c}} \dots\dots\dots \text{for a trussed bridge}$$

where  $\gamma_c = y \div \frac{pl^4}{8EI_c}$

$y$  in the first equation = deflection at  $x$  from the left support,

$p$  = uniform live load per unit length,

$I_c$  = moment of inertia of plate-girder at centre of span,

$w$  = dead load per unit length,

$$\lambda = \frac{\int_0^l \gamma_c^2 dx}{\int_0^l \gamma_c dx} \quad (\text{Table of } \lambda \text{ is given}),$$

$$c = 0.299 \left\{ \frac{-1}{(2-b)(3-b)(4-b)} \cdot \frac{\phi_2}{\phi_1} \right\}^{\frac{1}{2}},$$

$$y \text{ in the second equation} = \frac{-p}{2aE(2-b)(3-b)(4-b)} \left\{ (4-b)lx^{3-b} - (2-b)x^{4-b} - \frac{l^{3-b}x(4-b)^2}{2^{3-b}} \right\},$$

$$\phi_1 = \int_0^{\frac{l}{2}} y dx \div \frac{-p}{2aE(2-b)(3-b)(4-b)} \left( \frac{l}{2} \right)^{5-b},$$

$$\phi_2 = \int_0^{\frac{l}{2}} y^2 dx \div \left( \frac{l}{2} \right)^{9-2b} \left\{ \frac{p}{2aE(2-b)(3-b)(4-b)} \right\}^2,$$

$$I = ax^b \quad a = \left( \frac{2}{l} \right)^b I_c \quad b = \frac{\log \frac{I_c}{I_b}}{\log \frac{n}{2}},$$

$n$  = number of panels of the bridge.

Applying these formulas, the author obtained 0.23 second for the period of the vibration of a plate-girder bridge of 70 ft. span and 0.352 and 0.203 second for a Warren trussed bridge of 100 ft. span with and without live load respectively. The influence of the periodic action caused by the unbalanced force of driving wheels of locomotives is also investigated. The author gave a theoretical basis of the practical formula  $I = \frac{c}{l}$  and  $I = \frac{c}{c' + l}$  where  $I$  is the ratio of the maximum deflection due to vibration to the statical deflection, and  $c$  and  $c'$  are certain constants. The former formula may be applied for the cases when the period of free vibration of a bridge resonates with the periodic action and the latter for the contrary cases.

At the end of this paper various resistances to damp the oscillation of bridges are discussed. K. Y.

**3. Calculation of Longitudinal Strength of a Culvert** (Japanese). **Masaji SUZUKI.** [J. Civ. Eng. Soc., X., 1 and 2 (1924), 151-168 and 367-382, with diag. and fig.]—Usually a culvert under a river bank is so designed as to give ample transversal strength. The culvert, however, has a varying surcharge along its length. The author has pointed out this fact and given the following formulas for the transversal strength of a culvert.

$$\begin{aligned}
 p &= Cy \\
 y &= \frac{\rho h}{Cp^2} \left\{ (l_1 - l_2)x + (l_1^2 + l_2^2) \right\} \\
 M &= \frac{\beta \rho h}{l^2} \left\{ -\frac{(l + 2l_1)l_2}{6l_1} x^3 - l_1 l_2 x^2 + \frac{l_1 l_2 (l_2 - l_1)}{2} x + \frac{l_1^2 l_2^2}{3} \right\} \quad \text{for river side} \\
 &= \frac{\beta \rho h}{l^2} \left\{ \frac{(l + 2l_2)l_1}{6l_2} x^3 - l_1 l_2 x^2 + \frac{l_1 l_2 (l_2 - l_1)}{2} x + \frac{l_1^2 l_2^2}{3} \right\} \quad \text{for land side} \\
 Q &= \frac{dM}{dx} = \frac{\beta \rho h}{l^2} \left\{ -\frac{l_2(l + 2l_1)}{2l_1} x^2 - 2l_1 l_2 x + \frac{l_1 l_2 (l_2 - l_1)}{2} \right\} \quad \text{for river side} \\
 &= \frac{\beta \rho h}{l^2} \left\{ \frac{l_1(l + 2l_2)}{2l_2} x^2 - 2l_1 l_2 x + \frac{l_1 l_2 (l_2 - l_1)}{2} \right\} \quad \text{for land side}
 \end{aligned}$$

where

$p$  = intensity of reaction at base of culvert,  
 $M$  = bending moment of culvert at  $x$ ,  
 $Q$  = shear of culvert at  $x$ ,  
 $\beta$  = width of culvert,  
 $\rho$  = weight of earth per unit volume,  
 $C$  = constant,  
 $y$  = amount of settlement of culvert at  $x$ ,  
 $l$  = total horizontal length of culvert,  
 $l_1$  = horizontal length of culvert from centre line of top of river bank to rear toe,  
 $l_2$  = horizontal length of culvert from centre line of top of river bank to river side toe,  
 $h$  = maximum intensity of surcharge under centre line of top of river bank.

The origin of  $x$  is taken under the centre line of the top of the river bank and the positive  $x$  is measured to the river side.

These formulas were obtained after a series of reductions of differential equations of the fourth order from the theories of elasticity, assuming the surcharges to be a traction forming a triangle and the reaction at the base to be a uniformly varying traction.

The author gives a numerical example at the end of this paper.

K. Y.

**4. *Symposium on the Damage done by the Recent Earthquake and Emergency Measures taken at Various Engineering Works*** (Japanese). **Chikatami SOYAMA, Manabu KAGAYAMA, Orizō OGAWA and Kiichi TAKE-NOUCHI.** [J. Civ. Eng. Soc., X., 2 (1924), 207-255, with diag., fig. and maps.]—The paper covers the following four subjects.

(1) Street railway in Tokyo.

The total loss caused by the earthquake on the Street Railway of Tokyo is estimated to be over ¥40,000,000, of which one third is that of cars and trucks. Traffic by the street railway was stopped all at once by the quake. Covered or underground substances such as cable lines were safe and free from fire, while the surface structures such as substations, car sheds, overhead trolley wires and tracks under construction were severely damaged. Side poles proved to be more unfavourable to fire than centre poles.

The most serious damages are summarised as follows:—

9 substations, 6 car sheds, 779 cars out of 1,905, 26 principal bridges (4,331 ft. long in all).

Soon after the earthquake 13 rotary converters were sent from Ōsaka. Two bridges over the Sumida river about 520 ft. in total span were built by a battalion of engineers within a fortnight.

A part of the service of the Tokyo street railway was opened five days after the earthquake, and its mileage gradually increased, 180 miles out of a total mileage of 192 having been reconstructed by the end of the following February.

(2) The government railway.

Damage on the government railway is summarized as follows:—

Total mileage, 417.

Earth embankments, 44 miles.

Cuttings, 400,000 cub. yd.

Stone walls, 24,000 sq. yd.

Tunnels, 65,000 ft. (out of 130,000 ft.)

Stations, 191.

Track (burnt), 8 m. 30 ch.

Trains, 18 trains.

Almost all earth embankments near the origin of the earthquake were thrown flat. The surface of cuttings partially crumbled. Abutments of bridges were broken at the bottom of the breast walls, the piers were cut horizontally at about 1 or 2 ft. above the ground-level and the well-foundations were crushed at about 10 ft. below the water level. Almost all tunnels collapsed at their portal or within 20 ft. from their portals.

Emergency measures were taken with the co-operation of railway engineers from all parts of the country and the service on the Tōkaidō line was opened on Sept. 20th.

(3) The Tokyo water works.

The intake at Hamura was not damaged. Both longitudinal and transversal hair cracks appeared in the concrete lining of the water way of the open channel at a place about 2 miles from the settling reservoir at Yodobashi. One settling reservoir and one

service reservoir were slightly damaged. Water mains were broken at their joints and about 193 water-pipes collapsed. As the service pipes melted in the fire, a great quantity of water was wasted.

Where a high embankment of about 30 ft. height collapsed, a wood flume was built for temporary use. To meet the pressing need of drinking water, pumps were installed at the old water channel built about 270 years ago, so as to pump water into the settling reservoir, and water was also supplied by automobile water tank trucks to districts where required.

(4) Road and highway bridges in Tokyo.

The damages to bridges is tabulated as follows:—

	Wood	Metal	Stone	Concrete	Reinforced Concrete	Total
Total number of bridges	417	60	174	4	47	657
Broken bridge {	burnt	273	16	—	—	289
	collapsed	6	29	10	2	69
	total	279	55	10	2	359

As to the road problem, nothing was more urgent than the clearing away of all sorts of rubbish which covered the streets. The amount of rubbish was estimated to be at least 800,000 cub. yd. It was carried to the district situated to the East of the Sumida River for the purpose of elevating low land.

K. Y.

**5. Lot Adjustment for Town Planning in Tokyo** (Japanese). **Rintarō NAOKI**. [J. Civ. Eng. Soc., X., 2 (1924), 257-268.]—This is an address by Dr. Naoki who was formerly the general director of the Reconstruction Department of Tokyo and Yokohama.

The first scheme which aimed at planning an ideal city had been to buy all the lots which were burnt by the conflagration following the earthquake, and to sell them back to the former owners after adjustment. This plan was severely opposed by the advisory committees, and the Diet decided that roads of more than 12 ft. wide should be constructed at national expense, and those under 12 ft. wide with prefectural or municipal funds. The Diet also agreed to force land owners to offer 10% of their land to complete the new town planning scheme.

The total area to be rearranged was subdivided into sixty five sections. In each section a special committee was established to consult about the assessment of the lots

1) before the earthquake, and 2) after adjustment. This system proved very successful.

K. Y.

**6. On Spiralled and Rodded Concrete Column.** **Keijirō OGAWA**. [J. Civ. Eng. Soc., X., 2 (1924), 312-342, with fig.]—The subject is divided into the following four sections:—(1) Descriptions are given of the construction and the execution of spiralled concrete columns, and spiralled and rodded concrete columns, (2) The deformations within the limit of working stresses are fully dealt with, (3) The formulas for the calculation of the ultimate strength and ultimate load of the column are worked out from mathematical and mechanical points of view, (4) Formulas formerly used are historically reviewed and criticized.

K. Y.

**7. On the Fluidity of Portland Cement Paste** (Japanese). **Tokujiro YOSHIDA**. [J. Civ. Eng. Soc., X., 4 (1924), 763-774, with diag. and fig.]—It is



accepted as a fact that the workability and the strength of concrete largely depend on the property of its cement paste. Impressed by this fact the author carried out a series of laboratory studies regarding this point on the Portland cement manufactured by three principal Japanese companies. The results are as follows:—1) water comes out to the surface of the cement paste if it contains more water than 20% of the weight of cement used and this means some segregation of cement in the water; 2) the volume of the cement paste is minimum when the water-content is 15% and thenceforth the volume increases proportionally with the water-content as far as 50% of cement by weight. The cement-content in the unit volume of cement paste is maximum when it contains water amounting to 15% of the cement by weight; 3) the compressive strength of the cement paste decreases as its water-content increases, but the curve obtained by the author differs a little from that of Prof. D.A. Abrams given in the Bulletin 1, Structural Materials Research Laboratory, Lewis Institute, Chicago, page 3; 4) the author introduces a new device to test the fluidity of fluidal cement-paste, which cannot well be measured by the slump test or by the method of the Bureau of Standards of U.S.A. The apparatus is essentially a hollow cast iron cylinder, of 75 mm. in inner diam. and 150 mm. in height, which has a piston and is fitted with wooden board on the top. The piston makes the bottom of the cylinder and is to be pushed upward when the cylinder is filled with cement paste. The upper wooden board, on which the raised cement paste is to be spread, makes the flange of the cylinder at the upper edge. The fluidity can be measured by the ratio of the diameter of the spread cement paste to the inner diameter of the cylinder.

K. Y.

**8. *An Experiment on the Flow of Water at the Outlet of a Channel*** (Japanese). **Noboru YAMAGUCHI.** [J. Civ. Eng. Soc., X., 4 (1924), 773-788, with fig. and phot.]—This is the report of a series of experiments to confirm the results of the mathematical investigations on the same subject which were published in J. Civ. Eng. Soc. Vol. VII., 5 Oct. 1920. This experiment was made with a parallel edged flume of 0.5 ft. wide which is fitted in turn within a larger flume of 4.0 ft. wide and 30 ft. long. The mouth of the inner flume is situated at the middle of the length of the outer flume. The flumes were so constructed that their slope may be changed from 1 in 90 to 1 in 1,140. The lines of flow, the eddies, and their developments and transformations at the outlet of the inner flume under various conditions, are shown by photographs.

K. Y.

**9. *Reconstruction Works of Tokyo and Yokohama*** (Japanese). **Enzō ŌTA.** [J. Civ. Eng. Soc., X., 5 (1924), 867-1048, with diag., fig., maps and pl.]—This is description containing all the plans and designs of the above subject, and consists of the following chapters:—

- (1) The organization of the reconstruction work.
- (2) The approved budget of the estimated cost of the work.
- (3) The outline of the work.
- (4) Special legislation for the reconstruction work.
- (5) Roads.
- (6) Bridges.
- (7) Channels.
- (8) Parks.
- (9) Tokyo central market.

- (10) Lot adjustments.
- (11) Barracks.
- (12) Rearrangements of underground pipings.
- (13) Materials and machines used in the work.
- (14) Allocation of the districts as official, commercial, residential and industrial quarters.
- (15) Fire-proof districts.
- (16) Proposed town-planning for the intact districts.
- (17) Rapid transit railways in Tokyo.
- (18) Tokyo Harbour.
- (19) The channel connecting Tokyo and Yokohama.
- (20) Greater Tokyo.

K. Y.

**10. Notes on the Vertical Motion of an Earthquake and on the Vibration of Structures** (Japanese). Nagaho MONONOBE. [J. Civ. Eng. Soc., X., 5 (1924), 1063-1094, with diag. and fig.]-In the first part of this paper the author discusses the theories on the stability of a structure under the joint action of the vertical and horizontal vibrations caused by an earthquake. It is proved that the destructive seismic strength of retaining walls and gravity dams is equivalent to that of the purely horizontal vibration having an acceleration  $Kg$ , which is expressed by  $Kg = \frac{k}{1-k_1}g$ ,  $k$  and  $k_1$  being respectively the ratios of the horizontal and vertical components of seismic acceleration to the gravitational acceleration  $g$ .

Deducing from Rankine's formulæ, the earth pressure on a retaining wall with a vertical back surface, under seismic vibration, is given as follows:-

$$P = \frac{H^2 \omega}{2} (1-k_1) E$$

$$E = \frac{\cos \theta_0 \left[ \left\{ \cos (\theta_0 - \theta) - \sqrt{\cos^2 (\theta_0 + \theta) - \cos^2 \varphi} \right\}^2 + \left\{ \sin (\theta_0 + \theta) - \sin (\theta_0 - \theta) \right\}^2 \right]^{\frac{1}{2}}}{\cos^2 \theta \left\{ \cos (\theta_0 + \theta) + \sqrt{\cos^2 (\theta_0 + \theta) - \cos^2 \varphi} \right\}}$$

where

$P$ =total earth pressure on the vertical wall,

$H$ =height of wall,

$\omega$ =weight of unit volume of earth,

$\theta_0$ =surcharge angle,  $\theta = \tan^{-1} K$  or  $K = \tan \theta = \frac{k}{1-k_1}$ ,

$\varphi$ =angle of repose of earth,

and

$$\alpha = \alpha_1 + \theta_0, \quad \sin \alpha_1 = \frac{\sin \theta}{E} \left\{ \cos (\theta_0 + \theta) + K \sin (\theta_0 + \theta) \right\},$$

where  $\alpha$  represents the inclination of  $P$  to the horizontal line.

Next the earth pressure on a retaining wall with an inclined back surface under a similar condition is given. As the passive pressure on the back of the wall decreases by the seismic vibration, these structures are apt to slide and sink. To prevent these destructive actions, the necessary depth of the foundation is considered.

In the latter part of this paper, the analytical solution of the forced rocking motion of a rigid body is discussed. The stability of such a body does not depend only on its form; i.e. the ratio of its height to the length of the base, but also on its

size. The author introduces a formula on the period of vibration of framed structures. After studying the forced vibration of an elastic cone, fixed at the base, the author gives its deflection ( $u$ ) and bending moment ( $M$ ) as follows:—

$$u = \frac{e}{\Phi(\mu l) \Psi'(\mu l) - \Phi'(\mu l) \Psi(\mu l)} \{ \Psi'(\mu l) \Phi(v) - \Phi'(\mu l) \Psi(v) \}$$

$$M = \frac{e E I_1}{\Phi(\mu l) \Psi'(\mu l) - \Phi'(\mu l) \Psi(\mu l)} \left( \frac{x}{l} \right)^4 \{ \Psi'(\mu l) \Phi''(v) - \Phi'(\mu l) \Psi''(v) \}$$

where  $x$  is measured vertically downwards from the vertex, and  $e$  is seismic amplitude,  $T$  period of seismic vibration,  $l$  height of cone,  $\rho$  and  $E$ , respectively density and modulus of elasticity of the material,  $A_1$  and  $I_1$  respectively the sectional area and the moment of inertia at the base of the cone and

$$v = \mu x$$

$$\mu = pl \sqrt{\frac{\rho A_1}{E I_1}}$$

$$p = \frac{2\pi}{T}$$

$$\Phi(v) = \frac{1}{1 \cdot 2} + \frac{v}{(1)^2 \cdot 2 \cdot 3} + \frac{v^2}{(1 \cdot 2)^2 \cdot 3 \cdot 4} + \dots$$

$$\Psi(v) = \frac{1}{1 \cdot 2} - \frac{v}{(1)^2 \cdot 2 \cdot 3} + \frac{v^2}{(1 \cdot 2)^2 \cdot 3 \cdot 4} - \dots$$

$$\Phi'(v) = \frac{d}{dv} \Phi(v), \quad \Psi'(v) = \frac{d}{dv} \Psi(v), \quad \Phi''(v) = \frac{d^2}{dv^2} \Phi(v) \quad \text{and} \quad \Psi''(v) = \frac{d^2}{dv^2} \Psi(v).$$

K. Y.

**11. On the Stresses and Deflections produced in Rectangular Slabs** (Japanese). **Shikazō IGUCHI.** [J. Civ. Eng. Soc., X., 6 (1924), 1169-1275, with diag., fig. and tables.]—This paper gives the results of a theoretical study to determine the deflection, bending moment and shear at any point of a rectangular slab. The deflection of a slab is assumed to be expressed by the infinite series of triangular functions by Harger's method. From this assumption, the formulas for bending moment, shear, and energy equation are derived. The author shows calculation tables and diagrams for the following cases:—

(1) Rectangular slab, with four sides fixed and under uniform load; (2) rectangular slab, with three sides fixed and one side free, a) under uniform load b) under uniformly varying load, with intensity maximum at the free side and zero at the opposite side and c) under uniformly varying load, with intensity zero at the free side and maximum at the opposite side. The last case is directly applicable to the design of retaining walls with buttresses.

K. Y.

**12. General Theory on Earth Pressure and Seismic Stability of Retaining Wall and Dam.** **Saburō OKABE.** [J. Civ. Eng. Soc., X., 6 (1924), 1277-1324, with fig. and pl.]—The subject is divided as follows:—(1) the solution of Coulomb's theory on earth pressure, the cohesion of the earth being taken into account; (2) the general solution of earth pressure, seismic force being considered; (3) the seismic stability of a retaining wall and a gravity dam; and (4) some suggestions for the ideal design of retaining walls, and a numerical example on the design of the new quay-wall at Yokohama Harbour.





base and (c) elastic foundation, where resultant force acts within the base and (2) dams of rigid foundation (a) where the resultant force passes outside the base and (b) where the resultant force acts within the base.

After discussing the stability of retaining walls and dams, the author gives suggestions for the design of them. K. Y.

13. *The Past and Present States of Civil Engineering Work in Japan* (Japanese). Sadasaburō NAKAHARA. [J. Civ. Eng. Soc., X., 1 (1924), 1-8.]

14. *Report on the Construction of Rapid Filter Plant in the Second Extension of the Dairen Water Works* (Japanese). Yoshio KURATSUKA. [J. Civ. Eng. Soc., X., 1 (1924), 9-48, with pl.]

15. *On the Use of Trusses in Bridge-building* (Japanese). Shigeyuki HASHIMOTO. [J. Civ. Eng. Soc., X., 2 (1924), 269-296, with pl.]

16. *Notes on Dredges* (Japanese). Seikichi KANŌ. [J. Civ. Eng. Soc., X., 3 (1924), 435-562, with pl.]

17. *Geological Investigations made for the Tokyo Underground Railway* (Japanese). Shigeyoshi ITAKURA. [J. Civ. Eng. Soc., X., 3 (1924), 633-654, with fig. and pl.]

18. *Damage caused by the Recent Earthquake to the Yokohama Harbour Works, and the Repair thereof* (Japanese). Kyōichi AKI. [J. Civ. Eng. Soc., X., 4 (1924), 693-706, with phot. and pl.]

19. *The Reinforced Concrete Hollow Dam for the Hakodate Water-Works* (Japanese). Motoki ONO. [J. Civ. Eng. Soc., X., 4 (1924), 737-760, with diag., maps, phot. and pl.]

20. *Report on the Earthquake Damage to Local Railways and Tramways* (Japanese). Private Railway Administration Bureau. [Bull. Imp. Gov. Rwy. Research Office, XII., 2 (1924), 87-96, with tables.]

21. *Automobile Accidents at Highway Grade Crossings* (Japanese). Transportation Section, Traffic Bureau. [Bull. Imp. Gov. Rwy. Research Office, XII., 7 (1924), 645-668, with diag. and pl.]

22. *Effects of the Earthquake Shock upon Artesian Wells* (Japanese). Research Office, Department of Railway. [Bull. Imp. Gov. Rwy. Research Office, XII., 9 (1924), 865-867, with a fig. and a table.]

23. *Report on the Effectiveness of Guard Rails to Reduce Rail Wear Laid at the Shinjuku Station Yard* (Japanese). Jintarō MASUYAMA. [Bull. Imp. Gov. Rwy. Research Office, XII., 10 (1924), 999-1004, with fig.]

**24. *Report on the Repair Work performed on Sarubane Tunnel No. 1, Ōu Main Line*** (Japanese). **Maintenance and Improvement Section, Sendai Division.** [Bull. Imp. Gov. Rwy. Research Office, XII, II (1924), 1055-1084, with fig., phot. and pl.]

**25. *On the Slump Test of Concrete*** (Japanese). **Yoshio ŌSAWA.** [Bull. Imp. Gov. Rwy. Research Office, XII, 12 (1924), 1233-1237, with diag. and fig.]

**26. *Report of the Earthquake Damage to Mineoka Tunnel on the Awa Line and the Repair thereof*** (Japanese). **Shigeyuki HASHIMOTO.** [J. Imp. Rwy. Assoc., XXV., 2 (1924), 117-124, with phot. and pl.]

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## MECHANICAL ENGINEERING (1—32).

**1. Formula for the Strength of Struts.** Tsuruzō MATSUMURA. [J. Soc. Mech. Eng. Tokyo, XXVII., 81 (1924), 1-11, with fig. and a table.]—A new empirical formula for the strength of struts is proposed, which may be written in its general form as

$$P = FK \left\{ 1 + \left[ \frac{K}{\pi^2 E} \left( \frac{l}{i} \right)^2 \right]^n \right\}^{-1/n}$$

Ordinarily  $n$  may be taken at 2 with which the general formula reduces to

$$P = FK \left\{ 1 + \left( \frac{K}{\pi^2 E} \right)^2 \left( \frac{l}{i} \right)^4 \right\}^{-1/2}$$

The validity of this formula is proved by the experimental results obtained by Natalis and Tetmajer.

For cast iron struts  $n$  may be taken at  $5/4$  and with this value the general formula becomes

$$P = \alpha FK \quad \text{with} \quad \alpha = \left\{ 1 + \left[ \frac{K}{\pi^2 E} \left( \frac{l}{i} \right)^2 \right]^{5/4} \right\}^{-4/5}$$

It is shown that this formula accords very well with the experimental results obtained by Tetmajer.

The values of  $\alpha$  for  $\sqrt{\left( \frac{K}{\pi^2 E} \right) \frac{l}{i}} = 0.1$  to 3.5 are given in a table. Author.

**2. Study on Casting-stresses.** Ihei SUGIMURA. [J. Soc. Mech. Eng. Tokyo, XXVII., 81 (1924), 13-52, with fig. and tables.]—Investigations were made upon various items, such as (a) the determination of the most suitable form of the specimen, which is easiest to make, to machine and to handle, and in which the stress is induced so severely that errors accompanying their measurement do not introduce any serious effects in the results; (b) influence of casting temperatures on casting-stresses; (c) casting-stresses induced in green and dry sand mould castings; (d) position of the pouring gate and its effects on casting-stresses; (e) casting-stresses when chills are used at some parts of casting; (f) casting-stresses due to the lapse of time; and further items having the most practical importance, (g) diminution of casting-stresses due to heat-treatment were dealt with, and it was found that at a definite temperature and by a certain duration of heating, it was possible to completely release the casting-stresses.

In addition to the heat-treatment, (h) alteration of physical properties due to annealing was studied.

A Résumé and a Bibliography are attached.

Author.

**3. On the Holding Power of Boiler Tubes** (Japanese). Saiichirō UCHIMARU, Jirō TAKENAKA and Kameichi YUASA. [J. Soc. Mech. Eng. Tokyo, XXVII., 82 (1924), 127-133, with diag., fig. and table.]—An experiment on the holding strength of the expanded tube joints used in boilers, such as smoke tubes or water tubes.

The following remarks are given as a summary of the experiments:—

(1) The holding strength varies greatly even with the same kind of test pieces. This is to be attributed to the difference in their expansion.

(2) The point of the maximum holding strength occurs when joints have yielded from  $1/2$  to 2 mm. This shows that most tube joints can stand against a force exceeding the yielding strength of the tube.

(3) In some conically flared tube joints their strength is more than that of the tube itself.

Authors.

**4. Form of a Circular Ring under a Pair of Diametrically Opposite Forces.** Seinen YOKOTA. [J. Soc. Mech. Eng. Tokyo, XXVII., 83 (1924), 143-146, with fig.]—When a thin circular ring of uniform section is pushed in or pulled out by a pair of diametrically opposite forces in its plane, several interesting figures appear. The paper deals with all possible cases. The co-ordinates of the deformed ring are given in terms of elliptic functions.

Author.

**5. Shrinkage, Contraction and Density of Cast Iron due to Different Pouring Heads.** Ihei SUGIMURA. [J. Soc. Mech. Eng. Tokyo, XXVII., 83 (1924), 147-160, with fig. and tables.]—With ordinary grey iron, as was used in the present investigation, the results of shrinkage tests due to different pouring heads are summarized as follows: After the metal is poured into the moulds, it first expands and then contracts, and the high head casting expands more than the low head, but contracts less, provided sound castings be secured. The mean density of low head iron, as is usually considered, is less than that of high head iron, varying as the difference of heads; the higher is the head, the larger is the density, and vice versa. Furthermore, the density of the casting varies according to its distance from the pouring gate, regardless of the height of the head.

Author.

**6. On the Effect of Fillet on the Endurance of Metals.** Chūsaburō SHIBA and Kameichi YUASA. [J. Soc. Mech. Eng. Tokyo, XXVII., 84 (1924), 209-243, with fig., and tables.]—Test pieces were cut out from one block of billet of Siemens-Martins' open hearth steel and heat-treated in the same method, and then carefully finished into six different forms, so as to have six different sizes of fillet at the root of the test pieces, the length of their plain part being made equal in all cases.

All the physical and chemical properties of the material were carefully observed.

The test pieces were continuously rotated until breaking by the White-Souther repeated bending tester. The results of the experiments show that the limiting stress to be allowed for each kind of the test pieces greatly depends upon the size of the fillet.

A summary of the results follows:—

Series of Test Pieces.	Radius of Fillet. R.	Approximate Limiting Stress. lbs./sq. in. $f_l$	Tenacity. lbs./sq. in. $f_u$	$f_u/f_l$
I	1"	37,000	76,300	2.07
II	$1/2$ "	33,000	77,800	2.36
III	$1/4$ "	29,000	77,300	2.66
IV	$1/8$ "	27,000	79,800	2.95
V	$1/16$ "	17,500	79,400	4.54
VI	0"	13,000	77,800	5.98



In order to make clear the state of the distribution of stresses in the place where a fillet was formed, the photo-elastic method was adopted.

For this optical experiment, six models of cantilever beam made of transparent celluloid plate were prepared, each having the radii of fillet corresponding to those of the test pieces.

Though, in this case, it cannot be expected that the stress distribution is equal to that in the endurance test pieces, yet the general feature of stress distribution will be similar. By means of a comparison tester, made by the authors, the amount of stresses occurring in the various parts of the celluloid models were measured and are shown in the paper. As the conclusion, the authors propose to fix the radius of the profile of fillet as a certain fraction of the diameter or thickness of the body and recommend the alteration, if necessary, of the usual forms of machine parts, which have been adopted without paying much attention to the effect of fillets.

Authors.

**7. Preliminary Report of an Experiment upon Water Flow. Fujio YAMANOUCHI.** [J. Soc. Mech. Eng. Tokyo, XXVII., 84 (1924), 247-252, with fig. and pl.]—An ordinary photographic dry plate is fitted in any place where required in the water channel or pipe, the water flowing in it being fed with a developing solution. The dry plate is acted upon by the developer and clearly shows the stream line, eddies etc., thus demonstrating the nature of the flow of the water.

K. S.

**8. Evaporation of Locomotive Boiler with Superheater** (Japanese). **Kiichi ASAKURA.** [J. Soc. Mech. Eng. Tokyo, XXVII., 84 (1924), 253-265, with fig.]—The efficiency is expressed in terms of the rate of combustion and the ratio of the heating surface to the grate area.

The efficiency formula for the saturated steam locomotive boiler is also obtained.

The evaporation is expressed by the products of the rate of combustion, the grate area, the heat value of the coal used, the boiler efficiency and the reciprocal of the total heat of steam.

Authors.

**9. Theory of the Air-lift Pump with Special Reference to the Slip of Air Bubbles in Water. Otorō MIYAGI.** [J. Soc. Mech. Eng. Tokyo, XXVII., 85 (1924), 335-348, with fig., pl. and tables.]—The writer observed from experiments that an air bubble moving upwards in still water attains its maximum velocity almost as soon as it leaves the air nozzle, and subsequently it rises almost uniformly with that maximum velocity. This shows that the velocity of the slip of air bubbles in the eduction pipe of an air-lift pump is approximately constant all through its passages.

Expressed with the metric system of measurements and in common logarithms, the equation for the lift, submergence, etc., are obtained as follows:—

$$L = \{k\tau h 23 V \log P\} / Q \quad \text{or} \quad V / Q = L / \{23 k\tau h \log P\}$$

where  $V$  = volume of air supplied at the atmospheric pressure in cub. m. per sec.,  $Q$  = volume of water discharged in cub. m. per sec.,  $L$  = lift in m.,  $p$  = pressure of water expressed in atmospheres (absolute), which is roughly given by  $P = \frac{1}{10}S + 1$ ,  $S$  being the submergence in m.,

$$k = 1 - [2VQ(1 - 1/p) + V^2(1 - 1/p^2) + Q^2] \cdot Q / \{46 g \cdot l^2 V \log p\},$$

$A$  being the sectional area of the eduction pipe in sq. m., and  $g$  the acceleration of

gravity = 9.81 m. per sec. per sec.,  $\eta h$  = hydraulic efficiency, that is, the ratio of the actual lift to the theoretical one, and this involves various items such as the slip of air bubbles, hydraulic resistance in the pipe and at the foot-piece, etc.

The theoretical lift  $L_0$  is given by

$$L_0 = \frac{23V \log P}{Q} - \frac{VQ}{gA^2} \left(1 - \frac{1}{P}\right) - \frac{V^2}{2gA^2} \left(1 - \frac{1}{P^2}\right) - \frac{Q^2}{2gA^2}$$

The indicated efficiency  $\eta_i$  and the water horse-power  $N_w$  are respectively:—

$$\eta_i = QI / \{23 V \log P\}, \text{ and } N_w = 1000QI/75. \quad \text{Author.}$$

**10. Damage to Factories caused by the great Earthquake** (Japanese). **Zirō TAKENAKA**. [J. Soc. Mech. Eng. Tokyo, XXVII., 85 (1924), 349-369, with fig. and tables.]—Shortly after the great earthquake on Sept. 1, 1923, the writer visited more than fifty factories and power plants in the devastated area in Tokyo and its environs. He gives full accounts from his personal observations of the damage sustained by the factories and their equipments. He analyses the cause of the damage and points out what part was liable to be wrecked by the earthquake.

As the conclusion he suggests means to avoid the damage due to an earthquake.

Author.

**11. Vibrations of Turbine Blades.** **Akimasa ONO**. [J. Soc. Mech. Eng. Tokyo, XXVII., 86 (1924), 467-479, with fig. and tables.]—The natural vibration of clamped-free bars is investigated, assuming the cross section to vary as a certain power of the distance from the free end, and further simplifying the calculation by taking the radius of gyration to be constant.

The frequency of the gravest mode of vibration is expressed in a simple formula.

Next the vibration of flexible bars attached to the periphery of a rotating disc is dealt with under the same assumption taking the form of bars adopted in the preceding case.

The frequency is again expressed in a formula.

These two kinds of frequencies may be combined by Lamb-Southwell's method to give the approximate value of the frequency in rotation under the restoring forces, both elastic and centrifugal.

The calculation is applied to a turbine blade, and calculated frequencies of the blade at rest are compared with the values observed in the experiments, which are performed by recording the vibration on a smoked paper in one series, and on a sensitive film in another series.

The article consists of four sections, of which the first gives the outlines of the calculation, while the details of the calculation, the methods of the experiments, etc., are shown in the subsequent three sections.

Author.

**12. Experiments on the Impellers of a High Pressure Single-stage Turbine Pump** (Japanese). **Tokusaku ŌMORI**. [J. Soc. Mech. Eng. Tokyo, XXVII., 86 (1924), 480-504, with fig. and tables.]—At the exit from the impeller the absolute velocity of the water is suddenly decreased, and shock losses is the result.

To diminish the shock losses, it is advisable to sharpen the vane tips at the exit and to have sufficient clearance space between the impeller and the guide vanes.

First experiment were made to study the variation in the efficiency characteristics

of the pump, when the vane tips at the exit were sharpened and when not; and next further study was made by increasing the clearance space between the impeller and the guide vanes.

The results of the experiments are given both numerically and graphically.

Author.

**13. *Destruction of a Hydro-electric Power Plant by Snow*** (Japanese). **Otogorō MIYAGI**. [J. Soc. Mech. Eng. Tokyo, XXVII., 86 (1924), 505-516, with fig.]—A discussion on the causes of destruction of a hydro-electric power plant belonging to the Fukushima Electric Lighting Co. at Fukushima, which happened at about 3 p.m. on the 4th of March, 1923.

Author.

**14. *Analysis of the Quick-return Motions obtained by Slider Crank Chains***. **Katsutō YOKOYAMA**. [J. Soc. Mech. Eng. Tokyo, XXVII., 88 (1924), 666-673, with fig.]—Referring to the quick return motions obtained by slider crank chains such as crank and slotted lever or Whitworth quick-return motion mechanism, the displacement  $x$  of the body to which a quick return motion is to be given, can be expressed conveniently in terms of the angle  $\theta$  over which the driving pin has turned round.

If the angular velocity of the driving pin be known, the expression of the velocity and of the acceleration of the said body can be derived from that of  $x$  by successive differentiations.

These expressions remain the same, when the ratio  $m$  of the radius of the driving pin circle to the length of the fixed link is constant.

The length of stroke, the mean velocity, the maximum velocity, the ratio of cutting to return speed etc. of the reciprocating body are plotted in curves on a base  $m$ .

When  $m$  is greater than unity, the expression of  $x$  and accordingly those of the velocity and acceleration, can be applied to the crank and slotted lever mechanism, and if  $m$  is less than unity, the same expressions can be applied to the Whitworth quick-return motion mechanism.

The angular velocity of the driving pin of a crank and slotted lever mechanism may be made variable throughout one complete revolution of the pin, by means of the Whitworth mechanism as in the shaping machine of Mammutwerke in Nuerberg.

Author.

**15. *Effect of the Entrance Angle of Vanes on Characteristics of the Turbine Pump*** (Japanese). **Tokusaku ŌMORI**. [J. Soc. Mech. Eng. Tokyo, XXVII., 88 (1924), 692-726, with fig. and tables.]—Usually the entrance angle of vanes of the impeller is so selected that the flow at the entrance is radial.

But actually a whirling motion is set up in the suction pipe as the water approaches the impeller, and the absolute velocity of the water at the entrance to the impeller, even in the normal condition, may have a component in the direction of the rotation of the impeller.

In order to investigate the influence of the entrance angle of the vanes on the characteristics of the pump, six different impellers were constructed to study the several conditions of the flow at the entrance.

The result of experiments upon the six impellers are given in the attached tables and also shown in graphical form.

Author.

**16. On the Dynamics of Rotary Engines.** Keikichi TANAKA. [J. Soc. Mech. Eng. Tokyo, XXVII., 89 (1924), 769-792, with fig.]—A mathematical study on the motion of star mechanism of a rotary engine which has double obliquity. Author.

**17. Influence of a Varied Discharge on the Motion of Water and its Pressure in the Draught Tube of a Water Turbine.** Otogorō MIYAGI. [J. Soc. Mech. Eng. Tokyo, XXVII., 89 (1924), 793-804, with fig.]—In the draught tube of a water turbine the water whirls round the axis tracing a helical course down to the tail race, and the more the quantity of discharge differs from that of the ideal normal, the more augmented is this action. This action depends also on the radius.

Hydrodynamical calculations are made with three kinds of draught tubes, cylindrical, conical and hyperboloidal, and it is proved that the pressure just in contact with the inner surface of the draught tube is unchanged by varied discharges but the pressure inside it is very much influenced by the quantity of discharge and also by its form.

The distribution of pressure on any cross-section of the tube is parabolic, the pressure at the axis being sometimes minimum and sometimes maximum. Uniform pressure is realized only when the discharge is equal to a certain fixed amount, and when the discharge is much less than this amount a cavity is produced inside the tube forming a vacuum space which is not detected from the outside by means of pressure gauges usually attached on the tube wall. This is detrimental to the effective action of the tube.

In order, therefore, to avoid producing the cavity the turbine should be set so low that the pressure parabola formed on the upper-most cross-section of the tube even lies entirely above the possible vacuum line in the case of the smallest available discharge.

Author.

**18. The Effect of Surface Condition on the Fluid Resistance.** Masami ONO. [J. Soc. Mech. Eng. Tokyo, XXVII., 90 (1924), 859-868, with fig.]—From the fundamental equations of motion of viscous fluids, the author derived the conditions for the establishment of similar motions, the law governing the conditions being known under the name of Osborne Reynolds. He also introduced the idea of "Grenzschicht" and therefrom showed that this law is affected if there is a dissimilarity in the gradient of vorticity; this dissimilarity being most probably accounted for by dissimilar conditions. For mathematical deductions the original paper must be consulted.

K. S.

**19. On the Measurement of Variable Air Speed with a Pitot-static Tube.** Koroku WADA. [J. Soc. Mech. Eng. Tokyo, XXVII., 90 (1924), 869-875, with tables.]—The effect of acceleration on the velocity determination of a Pitot-tube relative to a fluid in which it is immersed, was investigated theoretically. The correction factor, to be multiplied to the indicated velocity neglecting acceleration, is found to be  $\frac{I_{2/3}(x)}{I_{-1/3}(x)}$ , where  $x = \frac{2h^{3/2}}{3 \cdot \frac{2}{C_d A}}$  and  $I_n(x)$  is the modified Bessel Function of the First Kind.

It is also shown that no correction is necessary when

$$\frac{2}{3} \sqrt{\frac{g c_w}{2\phi}} \cdot \frac{1}{R(1+x'/R)} \cdot \frac{h\omega^{3/2}}{C_\omega} > 16.5$$

to keep the error within 1%.

Author.



**20. Theory and Experiments on a Vapour Compression Refrigerating Machine with some Modified Cycles.** Haruhisa INOKUTY. [J. Soc. Mech. Eng. Tokyo, XXVII., 90 (1924), 876-912, with fig., pl. and tables.]—Of various attempts to improve the performance of the vapour compression refrigerating machine, two modified cycles are investigated. One of them is the multiple effect cycle, and the other the Plank cycle.

In Part I the theory of the multiple effect cycle satisfying the law of heat balance is established. To facilitate the solution of the problem, groups of curves showing the separator pressure, the total heat of the refrigerant just after the multiple effect injection and before the compression in the compressor cylinder, are drawn on the  $\phi$ - $T$  chart of the refrigerant.

A new regulating needle valve for the port is introduced, which is found to be effective in improving the efficiency of the multiple effect cycle.

The construction of the compressor cylinder is very much simplified owing to discovering the fact that only one small port is sufficient. In Part II the most favourable intermediate pressure of the low pressure compressor of the Plank cycle is studied.

The most favourable pressure is represented by a curve on the chart of the refrigerant. A new auxiliary compressor of an adjustable effective volume is designed to suit the condition required to obtain the maximum efficiency. The auxiliary high pressure compressor may be similar to a pump in its construction with a large clearance of about 135 per cent., for the reason that the refrigerant in it has a small compressibility and more resembles a liquid than a vapour.

With the multiple effect cycle the chief gain is in its capacity, and with the Plank cycle it is in its efficiency.

With the simultaneous application of the multiple effect and the Plank cycle, both the capacity and the efficiency can be increased. Experiments were carried out to prove these theories on an experimental refrigerating machine which can be operated on any of the three cycles, the ordinary, the multiple effect, or the Plank cycle. Author.

**21. Law of Comparison in the Total Resistance of a Rigid Body moving in Fluid.** Jirō ŌHASHI. [J. Soc. Mech. Eng. Tokyo, XXVII., 91 (1924), 963-970.]—Referring chiefly to the experiment with models of surface and totally immersed craft, a new idea is proposed which enables us to estimate the total resistance of a body measuring only the total resistances of two models on different scales.

Detailed investigations are made upon the items such as (a), when each model has the surface condition the same as that of the full sized body and (b), when the former has the surface condition different from that of the latter. Author.

**22. A New Harmonic Analyser** (Japanese). Kōjū NOGUCHI. [J. Soc. Mech. Eng. Tokyo, XXVII., 91 (1924), 975-984, with fig.]—A full description of a new type of the harmonic analyser devised by the author is given with an actual result of analysing an isosceles-triangular wave.

The so called "Henrici's Principle," shown by the following expression, makes the mechanical construction of a harmonic analyser simple. Let  $y=f(\theta)$ , then the two Fourier's coefficients of the  $n$ th harmonics can be transformed, by integration by parts, as follows :—

$$a_n = \frac{1}{\pi} \int_{\theta=0}^{2\pi} y \sin n\theta d\theta = \frac{1}{\pi} \left[ -y \frac{\cos n\theta}{n} \right]_0^{2\pi} + \frac{1}{n\pi} \int_{\theta=0}^{2\pi} \cos n\theta dy$$

$$b_n = \frac{1}{\pi} \int_{\theta=0}^{2\pi} y \cos n\theta d\theta = \frac{1}{\pi} \left[ y \frac{\sin n\theta}{n} \right]_0^{2\pi} - \frac{1}{n\pi} \int_{\theta=0}^{2\pi} \sin n\theta dy$$

In each of the above expressions, the term in brackets being zero, it is only necessary to make the mechanical integration of the last term which consists of 2 elements instead of 3 as in the left-hand one.

This principle has already been adopted in many types of harmonic analysers in use with various processes. This new type is so constructed as to give the value of the integral by relative motion between a horizontal plane and an integrating roller of the same type as those of an ordinary polar-planimeter, the plane being movable in the direction of  $y$  axis and the shaft of the integrating roller revolvable in a horizontal plane by a train of friction rollers. This instrument is applicable for any wave length from 0.5 cm. to 140 cm., and for any wave height under 60 cm., notwithstanding that the instrument has a small size of 10 cm.  $\times$  20 cm.  $\times$  35 cm.

The order of harmonics which can correctly be analysed by this instrument varies as the fundamental wave length, and is as follows:—

Fundamental wave length	5	10	20	50	100	140 cm.
Order of harmonics to the	10	15	20	25	30	35 th

Author.

**23. On the Torsion Test, First Report. Naojirō YAMANAKA.** [J. Soc. Mech. Eng. Tokyo, XXVII., 92 (1924), 1037-1084, with fig. and tables.]—When a round bar is subjected to torsion, there take place not only pure shearing strains crosswise to the axis, but also some axial and radial deformations, the amount of which cannot be neglected, especially when the problem of plasticity is treated.

The author conducted, as the first step, a series of experiments, in which observations were made upon the secondary strains as well as the modes of fractures, set up in bars under torsion.

Test were made upon round bars, solid and hollow, of mild steel and cast iron.

The conclusions derived from the results of experiments are:—

(1) The amount of axial deformation due to torsion differs considerably according as the test specimen is solid or hollow.

(2) The radial deformation differs not only in magnitude according as the specimen is solid or hollow, but also in sense as the material is cast iron or mild steel.

(3) The state of stresses in bars under torsion is much more complicated than has hitherto been generally supposed.

(4) The angle of fracture of a cast iron bar differs remarkably as the specimen is solid or hollow. In solid specimens the angle of fracture measured with reference to the circumference of transverse section ranges from 30 to 35 degrees, while in hollow specimens it is nearly constant being about 45 degrees. The author tries to explain the causes for inducing the secondary strains and their effects upon the stress distribution and the fracture.

Author.

**24. Theory of the Action of Railway Brakes** (Japanese). **Shōhei TANAKA.** [Bull. Imp. Gov. Rwy. Research Office, XII., 12 (1924), 1187-1232, with

diag. and tables.]—Observations on brake tests invariably reveal the fact that, under constant brake pressure and by initial speeds over 30 kms per hour, the retardation of the cars, and with it the coefficient of friction between the brake block and the wheel, remains constant for a considerable part of the braking period. This peculiar behaviour is explained theoretically by assuming that the greater part of the heat evolved at the contact surface of block and wheel is lost in the air, while the heated surface of the tyre is moving in the free atmosphere. Based on this assumption, from the consideration of balance between the heat evolved and that lost through conduction and surface cooling in the course of braking, a new formula for the coefficient of friction between block and wheel of the form

$$f = \frac{f_0}{1 + \frac{p}{\left(a + \frac{b}{v}\right) \left(1 - e^{-\frac{c}{v}}\right)}}$$

is deduced, where  $p$  is the pressure of one shoe,  $v$  the initial speed,  $f$  the coefficient of friction corresponding to  $p$  and  $v$ ,  $f_0$  the same when cool,  $e$  the base of Napierian logarithm, and  $a, b, c$  constants depending upon the dimensions and physical properties of the shoe and tyre. By putting  $p$  constant in the above formula we get the well known Wichert's formula as a special case. The actual coefficient of friction determined from a series of running tests with 12 bogie passenger cars weighing 406 metric tons including locomotive and tender, and equipped with Kunze-Knorr air brakes, agrees pretty closely with the values calculated from the above formula, which reduces to

$$f = \frac{0.4125}{1 + \frac{p}{1128 + \frac{18280}{v}}}$$

where  $p$  is expressed in kgs per shoe and  $v$  in kms per hour. The average block pressure used in the tests ranged between 225 and 820 kgs. It will be seen that the effect of the change of pressure on the coefficient of friction is far more pronounced than that of initial speed.

Author.

**25. On Water Hammering** (Japanese). **Kuraji MUSASHI**. [Bull. Imp. Gov. Rwy. Research Office, XII, 1 (1924), 1-21, with fig.]

**26. On the Tooth Profile of the Spur Wheel** (Japanese). **Shinsuke HASHIMOTO**. [Bull. Imp. Gov. Rwy. Research Office, XII, 2 (1924), 67-86, with fig.]

**27. Report of Experiments on the Vibration of Passenger Cars** (Japanese). **Kuraji MUSASHI**. [Bull. Imp. Gov. Rwy. Research Office, XII, 6 and 10 (1924), 471-481 and 949-955, with fig. and tables.]

**28. An Experiment on the Mechanical Efficiency of a Locomotive** (Japanese). **Kenjiro KUWABARA**. [Bull. Imp. Gov. Rwy. Research Office, XII, 9 (1924), 841-852, with fig. and tables.]

29. *Standard Formulae for Train Resistances* (Japanese). **Hideo KOBAYASHI**. [Bull. Imp. Gov. Rwy. Research Office, XII., 10 (1924), 923-947, with fig.]

30. *A New Apparatus for Measuring the Charging Efficiency of the Two-Stroke Engine* (Japanese). **Kiyoshi TOMIZUKA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 6 (1924), 13-27, with fig.]

31. *On the Characteristics of Hopkinson's Optical Indicator* (Japanese). **Masao YOSHII**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 6 (1924), 28-31, with fig.]

32. *An Experiment on the Characteristic of Various Types of Piston Deflectors of the Two-Cycle Engine* (Japanese). **Kiyoshi TOMIZUKA** and **Inesaburō ŌMURA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 7 (1924), 1-20, with fig.]

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## NAVAL ARCHITECTURE (1—7).

**1. On the Apparent Moment of Inertia of Ships** (Japanese). **Kyōji SUYEHIRO**. [J. Jap. Soc. N. A., **34** (1924), 14-18, with fig.]—This is a report of a preliminary experiment carried out by the author for his further investigations on the rolling of ships. He made a series of model experiments for the purpose of ascertaining; (1) whether the ratio of the virtual increase of the moment of inertia of a ship's model to its real value is the same among models of different dimensions but being similar in all respects, so far as the rolling is concerned, and (2) the effect of the change of the period of the rolling (keeping the displacement constant) on the virtual increase of moment of inertia for one and the same type.

With regard to (1), it was found that the said ratio had practically no scale effect, giving nearly the same value for models having similar form; this ratio being nearly 0.2 for models having a certain ship-shaped form and 0.9 for those having a rectangular shape. With respect to (2), the experiment revealed the fact that the virtual increase diminished linearly with the increase of the period of rolling. Author.

**2. Skin Friction Resistance and Law of Comparison.** **Atsumu SHIGEMITSU**. [J. Jap. Soc. N. A., **34** (1924), 19-58, with fig. and tables.]—The frictional resistance of ships is estimated by the empirical formula based on the towing experiments of plates. The author attempted to make an analysis of Gebers' data following Guembel's proposal, i.e. taking into consideration the viscosity of fluid as well as the roughness of the surface.

For the resistance due to viscosity, slightly different views have been taken by Blasius and Guembel. The resistance due to roughness is assumed by Guembel to be proportional to  $(VL)^2$ , while F. Gebers believes otherwise. Applying the principle of dynamical similarity to the said data, the author made an empirical formula which is slightly different from  $(VL)^2$  law.

Using this empirical formula for the resistance due to roughness and also Guembel's formula for the resistance due to viscosity, the author analysed Gebers' Vienna experiments and arrived at an interesting result showing the relation of roughness of surfaces and their frictional resistance. The resistance calculated by the new formula are in better agreement with the measured ones than those determined by Gebers' formula.

The author compares his formula with those of R. E. Froude and F. Gebers, applying them to speeds and lengths corresponding to those of ships and shows that;

(a) The author's formula agrees very well with Froude's formula when they are applied to small, slow ships such as the "Greyhound."

(b) For large vessels of high speeds, however, a considerable discrepancy occurs.

K. S.

**3. Steam Turbines as applied to Small Power Marine Installations** (Japanese). **Kaneo NIWA**. [J. Jap. Soc. N. A., **35** (1924), 39-70, with pl.]—The present paper is mainly the description of the design and construction of the machinery of a turbine screw steamer and states a conclusion, with the analysis of actual results, that the steam turbine is also suitable as a marine installation down to a power of at least some 400 or 500 S. H. P. per set. Author.

**4. *An Example of the Effect of Shallow Water on the Resistance of Ships*** (Japanese). **Kikuo FUJIMOTO**. [J. Jap. Soc. N. A., **35** (1924), 179-181, with fig.]—This paper is a report of the example of the effect of shallow water on the resistance of three mine sweepers which were built at Harima Dockyard, Tama Dockyard and Osaka Iron Works.

The speed trials of all these ships were held at Seto-Nai-Kai (i.e. Mirume off Kobe, off Sanuki and off Iyeshima) where the depth of water was not very deep, and the effects of shallow water on the speed were experienced.

- (1) Minimum depth of water where no effect of shallow water was observed.  
Comparing these results with Taylor's formula and Rota's experiment, the former was nearer to the actual results than the latter.
- (2) Amount of increase in horse power due to shallow water.  
Comparing the actual results with Rota's experiment, although the points do not exactly coincide, the tendencies of both curves were fairly close to each other.
- (3) In Seto-Nai-Kai the water is deep near the shore and the speed trials of fairly high speed ships can be done accurately by selecting a course near the shore after careful study of the chart.

Author.

**5. *On the Work Efficiency*** (Japanese). **Shigeru MASADA**. [J. Jap. Soc. N. A., **35** (1924), 83-135, with fig. and tables.]

**6. *Economy of Ship Repairs***. **John MARTIN**. [J. Jap. Soc. N. A., **35** (1924), 184-190.]

**7. *Electric Machinery for Marine Use*** (Japanese). **Minato TSUJI**. ["Zassan," Jap. Soc. N. A., **36-7-8** (1924), 21-27, with fig.]

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## AERONAUTICS (1—6).

1. *Kinematographic Study on Aeronautics, Provisional Report.* **Kwan-ichi TERAZAWA, Kichisuke YAMAZAKI and Yüzō AKISHINO.** [Rep. Aeronaut. Research Inst. Tōkyō Imp. Univ., I., 7 (1924), 213-224, with fig. and tables.] —The flow of air around aerofoils, rotating cylinders and propellers was studied photographically by adopting the shadow method of Dvořák and the striæ method of Töpler. Kinematographic pictures were taken at the rate of about 1200 per second by using periodic sparks of short duration as the illuminating source. The sparks were emitted by the secondary circuit of a transformer, the primary circuit of which is connected to a high frequency generator of 500 cycles per second. Several interesting pictures are reproduced, among which those showing the formation of eddies near the tip of an air screw and the explosion of a gas bag are very valuable. K. S.

2. *Relation between the Resistance and the Directional Stability of an Airship* (Japanese). **Katsutada SEZAWA.** ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 6 (1924), 32-34, with fig.]—The author attempts to verify experimentally the relation between the lateral stability and the resistance of airship models in fluid. The idea involved in this paper is original in that the resistance of ships can be expressed in terms of the period of the lateral oscillation, the speed and some quantities characterising the ships. Author.

3. *On the Free Vibration of a Metallic Plate fixed at Four Edges* (Japanese). **Katsutada SEZAWA.** ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 6 (1924), 39-42, with fig.]—An approximate solution of this problem started from the general equation of motion of a plate. The result was compared to an experiment made with gelatine plates. K. S.

4. *On the Vibration of Aeroplane Wings* (Japanese). **Katsutada SEZAWA.** ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 6 (1924), 43-45, with phot.]—The free vibration of model aeroplane wings was studied experimentally and it was found that the volume of the surrounding dead air oscillating with a wing was a few hundred times that of the wing itself. Author.

5. *A Method of Analysis of Fluid Resistance composed of Friction and Pressure* (Japanese). **Katsutada SEZAWA.** ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 6 and 7 (1924), 35-38 and 21-25, with fig.]—This investigation relates to an analysis of fluid resistance composed of friction and wave pressure by experimenting with three similar models in water tanks. The author aimed at separating the frictional and wave resistance without using frictional constants deduced from experiments with flat plates. For the purpose of confirmation an experiment was carried out with small models and the resistance was analysed into frictional and capillary components. Author.

6. *New Empirical Formula for Aeroplane Strength* (Japanese). **Satsuo TOKUNAGA**. ["Zatsurokn" of Aeronaut. Research Inst. Tôkyô Imp. Univ., **7** (1924), 26-31, with tables.]

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## TECHNOLOGY OF ORDNANCE (1—3).

**1. *On the Motion of a Fish Torpedo launched from an Above-water Tube*** (Japanese). **Tamotsu AOKI.** [J. Soc. Ord. and Exp., XVIII., 2 (1924), 47-70, with fig.]—In Chapter I the motion of a fish torpedo in an above-water tube is dealt with for two different cases, in one of which the pressure distribution in the tube is constant, and in the other variable.

In Chapter II the forces acting on the mount of the tube are determined.

In Chapters III and IV the motion of the torpedo from the muzzle to the sea level is discussed, assuming the torpedo to be a material point, and to be a rigid body. A numerical application to 18" torpedo is shown at the end of the paper. Author.

**2. *On the Motion of the Axis of Projectiles*** (Japanese). **Jūgo NAGASAWA.** [J. Soc. Ord. and Exp., XVIII., 3 (1924), 107-136, with fig.]—The author first explains some theories on the dynamics of rigid bodies relating to the above subject. Then he proceeds to deal with the motion of the axis of projectiles for the following cases:—(1) in vacuum; (2) in air, neglecting the action of gravity; (3) in air, taking the effect of gravity into consideration. T. M.

**3. *Second Report on the Performance of Blast using Carlit Explosive*** (Japanese). **Tsuneo NOHARA.** [J. Soc. Ord. and Exp., XVIII., 3 (1924), 137-164.]

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## ELECTRICAL ENGINEERING (1—47).

1. *On the Free Potential of the Grid and Plate of the Triode Valve and the Apparent Distribution of the Initial Velocity of Electrons* (Japanese). Heiichi NUKIYAMA and Toshita KUWASHIMA. [J. I. E. E. Japan, 425 (1923), 942-949, with fig.]—The free potential of the grid and plate of the triode valve was measured by means of a quadrant electrometer. The free potential of the grid was found to be negative in most cases even if the plate voltage were kept high by an external source of E. M. F. The effect of grid leak on the free potential of the grid was studied in detail and from this result the apparent distribution of the initial velocity of electrons was calculated.

The capacity of the quadrant electrometer was measured by heat method using a triode valve audio-frequency oscillator. From this value of capacity, the leakage of the quadrant electrometer and of the triode valve was determined by the time constant method. The time constant of the discharge of the quadrant electrometer increased when the grid was connected to the electrometer and the valve was filled with electrons by heating the filament previously. This is due to the space charge which gradually accumulates to the grid and discharges through the leak. By this conception the equivalent electrostatic capacity of the vacuum space of the valve was determined.

Author.

2. *On a Direct Method to Determine the Sense of Rotation of Braun Tube Diagrams* (Japanese). Kyūkichi SEIYAMA. [J. I. E. E. Japan, 425 (1923), 950-957, with fig. and pl.]—The author applies a stroboscopic method for the direct determination of the sense of rotation of Braun tube diagrams. The necessary additional implement is a thin metallic disc revolved by a suitable motor such as an induction motor connected to the same source as that of the diagram. The disc has small holes pierced at equal distances along the circumference of a concentric circle. If the diagram on the fluorescent screen is looked at along an imaginary line fixed in space through the holes of the revolving disc, a fluorescent spot may be seen to move in the same sense or opposite to the rotation of the diagram, according to the frequency of the diagram, the speed of the disc and the number of holes. If the number of holes be made equal to that of pairs of poles of the induction motor, the spot always seems to rotate in the same sense as the diagram.

The author makes several experiments to test this method. From the results of these experiments he confirms that the method is applicable in case of low and moderate frequencies.

M. H.

3. *On the Studies Regarding to the Telephone Receiver Output* (Japanese). Kinjirō OKABE. [J. I. E. E. Japan, 425 (1923), 977-988, with fig.]—An apparatus was designed for the purpose of the direct comparison of telephone receiver outputs, and some investigations regarding telephone receiver output were carried out. A receiver of which the resonance frequency is variable in a definite range of frequency is described in the appendix.

Author.

**4. On the Theory of the Induction Type Watt-hour Meter** (Japanese). **Tarō ŌTAKE** and **Nobuyoshi KATŌ**. [J. I. E. E. Japan, **426** (1924), 33-68, with fig.]—Under reasonable assumptions the authors determine the induced eddy current and the mean torque acting on the disc of the induction type watt-hour meter. First, the researches of Rogowski and Rüdenberg are explained and discussed in detail, for the sake of comparison. Next a fundamental differential equation is established under the first assumption that the disc is extremely thin, and the current function  $U/\tau$  is determined under the second assumption that the magnetic flux is known and limited only in the same area on the disc as that of magnetic poles. Then a simple approximate formula for  $U$  is obtained, adopting the third assumption that the magnetic pole is a circle and the magnetic induction uniform within it. Lastly the authors calculate the mean torque acting on the disc under the assumption above cited and compare it with the results obtained by Rogowski. M. H.

**5. Telephone Transformer and Design of Ideal Circuit** (Japanese). **Teiji MICHIDA**. [J. I. E. E. Japan, **427** (1924), 151-164, with fig.]—The transition loss, the argument loss and the transformer loss at the junction point of two circuits having different impedance are explained, and the ideal transformer which minimizes these losses is shown to be such that its primary and secondary impedances are conjugate to those of the circuits respectively. Next the author describes the methods of determining the terminal impedances to get an ideal circuit when these are connected to the terminals of any type of circuit, and also the method of designing a transformer which makes the circuit ideal when it is inserted at the junction point of two given circuits of different impedance. Author.

**6. An Electrodynamic Loud Speaker and its Motional Impedances.** **Kenzaburō KUROKAWA**. [J. I. E. E. Japan, **427** (1924), 165-181, with fig.]—An electrodynamic loud speaker tested is described in detail. The impedance characteristics of the active coil are found to be just the same as for ordinary telephone receivers. Damped or stationary and motional vector impedance graphs are respectively a straight line and a circle when the frequency is varied. The diameter of motional impedance circle coincides with the resistance axis, which for ordinary receivers is usually depressed below it. The diameter are 74.0, 194.0 and 290.0 ohms, respectively, for the d. c. excitation of 0.5, 1.0 and 1.5 ampere and without the trumpet. The first and second quadrantal resonance frequencies are respectively about 620, 616.5 and 624 for 1 ampere excitation. The variations of these frequencies for different excitation are very small. And the force factor for 1 ampere excitation is  $9.64 \times 10^6$  dynes per absampere. When, however, the trumpet is on, the motional impedance graph is reduced to about 1/16 of the size, and when it is off, the diaphragm motion is somewhat distorted for reproduction of speech although the system has a marked resonance point; and the graph is accompanied by a number of small loops, the trumpet being a multi-resonance system. The advantages of this instrument for acoustic impedance and similar measurements are explained. The action of such a vibrating system as an inductance or a capacitance is also described. Author.

**7. On the Correction Factor of the Air Gap Induction in Electric Machines** (Japanese). **Shigeo MOCHIZUKI**. [J. I. E. E. Japan, **427** (1924), 182-196, with fig.]—The flux distribution along the air gap in electric machines with open slots

is investigated experimentally by the electrodynamical method for the cases:—(1) with slots on one surface only, having infinite tooth permeability in one case and having constant tooth permeability in the other; (2) with slots on both opposing surfaces, having infinite tooth permeability. From the results obtained the author establishes an experimental formula for the air gap correction factor, and compares it with formulae proposed by many other investigators.

Author.

**8. On the Synchronization of an Induction Type Synchronous Motor** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **428** (1924), 207-226, with fig.]—The motion of the rotor of an induction motor during its synchronizing period with D. C. excitation may be expressed by a differential equation of the second order. This equation cannot be solved by the usual mathematical method, but lends itself to graphical solution. Two graphical methods are explained, the one being the differential method of Shio, and the other the integral method evolved by the author. First the author explains the manner in which the synchronization is effected and finds the relation between the limiting slip for synchronization and the magnitude of the D. C. magnetization, and then compares it with other investigators' results. Then the author considers the synchronizing phenomenon from practical points of view, and expresses the opinion that the gradual building-up of the D. C. magnetization is necessary for a smooth synchronization in order that the least disturbance may be caused on the main line. Means of fulfilling this requirement are considered and experiments on the characteristics of the D. C. exciter are described.

Author.

**9. On the Theory of Dielectric Hysteresis Loss in Fibrous Insulating Materials** (Japanese). **Yotsuo TORIYAMA**. [J. I. E. E. Japan, **428** (1924), 227-235, with fig.]—The author discusses the theory of dielectric hysteresis loss in fibrous insulating materials. The fibres in dried fibrous insulating materials are not a complete insulator but may be taken to form a number of small leaky condensers. If the fibrous insulating materials having small leaky condensers are put in an alternating electric field, there will be an electric loss due to the discharge through the leakage path of the condenser. From the above inference the author interprets the residual charge and dielectric hysteresis loss in the insulating materials. The author also describes ideal model fibrous insulating materials.

Author.

**10. On the Finishing Voltage of the Secondary Battery** (Japanese). **Sakae MAKIO**. [J. I. E. E. Japan, **428** (1924), 250-262, with fig.]—The author shows experimentally that the finishing voltage is mainly dependent upon the mechanism of the negative plate.

M. H.

**11. Second Report on Non-arcing Metals** (Japanese). **Heizaburō OYAMA**. [J. I. E. E. Japan, **428** (1924), 263-266, with fig.]—The author makes observations on long arcs of Cu, Zn and Brass. Cu arcs are stable, while Zn arcs become unstable at a great length. The character of brass arcs changes gradually from that of Zn to that of Cu. It is concluded that, when long arcs are lit between metal electrodes, the oxidation of the metal vapour in the arc stream is a paramount factor governing the non-arcing quality of the metal.

Author.



**12. On the Measurement of Natural-Frequency of an Inductance Coil at Audio-Frequency** (Japanese). **Heiichi NUKIYAMA** and **Katsuichirō KOBAYASHI**. [J. I. E. E. Japan, **429** (1924), 400-405, with fig.]—The authors utilize Campbell's frequency bridge to determine the natural frequency of a coil used as the primary of the mutual inductance, knowing the frequency of the current and the capacity, which gives the balance. The frequency is determined by standard tuning forks. To obtain the sharpness of the balance, a simple modification of the circuit is proposed. M. H.

**13. Parallel Concatenation of Induction Motors** (Japanese). **Tatsuichirō ISONO**. [J. I. E. E. Japan, **431** (1924), 517-544, with fig.]—The author explains the characteristics of parallel concatenation by the use of equations and circle diagrams, after describing the series concatenation of many induction motors. Parallel concatenation of two induction motors may be simply obtained by changing some connections of the series concatenation and easily started with one of the motors with a smaller number of poles. The speed of parallel concatenation is independent of the load and dependent upon the number of poles of the motors and the frequency of the line, and may be represented by a simple equation:—

$$n = \frac{120 \cdot f}{P} \quad \text{R. P. M.}$$

where  $f$  is the line frequency and  $P$  the mean number of poles of the motors. In the practical application of the method, a synchronous speed corresponding to an odd number of poles is obtained by the parallel concatenation of two induction motors. M. H.

**14. On the Thermal Resistance Formula of Three Core Sector Shaped Cables** (Japanese). **Kichizō SHIMIZU**. [J. I. E. E. Japan, **431** (1924), 559-563, with fig.]—An approximate expression for calculating the thermal resistance of three core sector shaped cables with equal thickness of dielectric between conductors and between conductor and sheath is found theoretically and compared with experimental and graphical values. The thermal resistance  $R$  may be calculated approximately by the formula:—

$$R = 0.087 \cdot \rho \cdot \log_e \left( 1.17 \frac{t}{r_0} + 1 \right),$$

where  $\rho$  is the thermal resistivity,  $t$  the thickness of dielectric between conductors or between any conductor and sheath, and  $r_0$  the radius of the circular conductor of equal sectional area with the sector conductor. Author.

**15. Motional Mutual Impedance of Telephone Receivers** (Japanese). **Heiichi NUKIYAMA** and **Masatoshi MATSUDAIRA**. [J. I. E. E. Japan, **431** (1924), 564-574, with fig.]—To investigate the vibration of the diaphragm of a telephone receiver having a small motional impedance, the authors measured the motional mutual impedance between the winding of the receiver and another winding attached to the diaphragm, the former acting as a driving coil and the latter as a measuring coil. It was found possible to reduce the damped mutual impedance to such a small value as  $10^2$  ohms.

By this method the mechanical impedance of the carbon powder of a solid back transmitter was measured. This paper also deals with the theory of the motional

mutual impedance of the receiver, and the theory and experimental results of the determination of the mechanical constants of the vibrating system. M. II.

16. *On the Behaviour of Discharger as a Lightning Arresters* (Japanese). Jūsuke ŌKŌCHI. [J. I. E. E. Japan, 432 (1924), 624-650, with fig.]—The author discusses the behaviour of the discharger as a lightning arrester and concludes that the arresters, having a series gap in modern practice, are undesirable. He proposes a combination of the discharger and the high frequency energy absorber as an ideal arrester. The principle of a high frequency energy absorber designed by the author is described. M. II.

17. *On the Variation of Residual Charge and the Ratio of Electrical Conductivity to Capacity due to Temperature* (Japanese). Hikoo SÆGUSA. [J. I. E. E. Japan, 432 (1924), 651-678, with fig.]—The variation of residual charge and the ratio of conductivity to capacity of some crystalline dielectrics and of some amorphous dielectrics are investigated experimentally by using a specially designed apparatus. M. II.

18. *On the Creeping of Induction Type Watt-hour Meter* (Japanese). Matsujirō ŌYMAA. [J. I. E. E. Japan, 432 (1924), 679-682, with fig.]—The creeping of the induction type watt-hour meter is discussed in relation to various types of the devices of preventing it. According to the author the error caused by the creeping is not to be overlooked when the load is light or of intermittent service of short duration. Author.

19. *Charging of the Transmission Line and Self-Excitation of Alternators* (Japanese). Masakazu TAKAHASHI. [J. I. E. E. Japan, 432 (1924), 683-715, with fig.]—The author proposes a graphical method to find the abnormal condition due to the self-excitation of alternators, taking the armature leakage reactance into account.

The results of actual test on machines coincide fairly with those shown by such curves. The same method is also applicable to obtain the saturation curve excited by the armature current with some field excitation.

The author compares the results obtained by the above graphical method with the actual test data obtained at the Yomikaki Power Station of the Daido Electric Power Company, and also at the Ryushima Power Station of the Keihin Electric Power Company, pointing out that there is a fair degree of coincidence. The above method holds good for both balanced and unbalanced three phase problems. The author further refers to miscellaneous problems concerning self-excitation. M. II.

20. *A New Harmonic Analyser* (Japanese). Kōjū NOGUCHI. [J. I. E. E. Japan, 433 (1924), 793-799, with fig. and pl.]—Practically the same as that abstracted on page 17.

21. *On the Grounding of a Long Distance Transmission Line Compensated through the Petersen Earth Coils* (Japanese). Takashi ŌTSUKI. [J. I. E. E. Japan, 434 (1924), S43-S47, with fig.]—The paper deals with

general equations of a transmission line with distributed inductances and capacities, having Petersen earth coils at the neutral points.

According to the theoretical investigation, an  $n$ -phase  $n$ -line long distance transmission system can be safely protected by installing two equal earth coils, one at the generating end and one at the receiving end of the line, as specified by the following equation, which holds good only for the resultant components of both sides.

$$Y_0 = n Y_s \left( \frac{1 - \cosh k_s l}{\sinh k_s l} \right), \quad Y_s = \sqrt{\frac{Y_{11}}{Z_{11} + (n-1)Z_{12}}} \quad \text{and} \quad k_s = \sqrt{[Z_{11} + (n-1)Z_{12}] Y_{11}}$$

where  $Y_0$  represents the required admittance of the coil,

$l$	„	the total line length,
$Y_s$	„	the surge admittance of the line,
$k_s$	„	the attenuation constant of the line,
$Y_{11}$	„	the capacity admittance of the line to the ground per unit length,
$Z_{11}$	„	the inductive impedance of the line per unit length, and
$Z_{12}$	„	the mutual inductive reactance of the line per unit length.

If the line is not very long, it may be protected by installing an earth coil at either the generating or the receiving end, specified as follows:—

$$Y_{0a} = -n Y_s \frac{\sinh k_s l}{\cosh k_s l},$$

where  $Y_{0a}$  represents the required admittance of the coil.

Author.

**22. On the Damped Oscillations Produced by Means of a Triode Valve** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **434** (1924), 860-886, with fig. and pl.]—The damped oscillations produced in an oscillatory circuit connected to any rectifier are studied. Generally speaking, there are two chances for their coming into existence, one being at the start and the other at the end of the rectified half cycle of current; the former being an oscillatory charging of the condenser in the anode circuit and the other its oscillatory discharge. If an alternating voltage of an appreciable magnitude is impressed upon the grid of an amplifier, the plate current pulsates and even vanishes during a certain portion of the period. Thus, owing to this rectifying character, damped oscillations result in the oscillatory anode circuit. The author determines experimentally and mathematically the critical frequency, the critical magnitude of the grid voltage, and the critical filament current, which are just necessary for the production of the damped oscillation.

A certain inductance in the plate circuit is found to be necessary for its production, forming an oscillation circuit with the internal static capacity of the triode.

M. H.

**23. Self Inductance and Natural Wave Length of Single Layer Coils for Radio Use** (Japanese). **Isamu YAMAMOTO**. [J. I. E. E. Japan, **435** (1924), 913-919, with fig.]—Various curves were plotted for practical convenience:—(1) curves which are necessary in designing the single layer coils giving certain self inductances; (2) the curve which shows the total length of wire of the coil; (3) curves which determine the approximate value of the natural resonant wave length of the coil; (4) curves which show the approximate value of the equivalent self capacity of the coil.

Author.

**24. Reflection Losses in Telephone Circuits** (Japanese). **Kazukiyo OGAWA**. [J. I. E. E. Japan, **435** (1924), 920-928, with fig.]—The writer proposes that the reflection loss should be expressed by the ratio of the electric power in the circuit. The formula is derived for the reflection loss from this point of view. A diagram is then given, which shows how the reflection loss varies for various impedances of the circuit. The degree of the reduction of the reflection loss by the inequality ratio transformer is considered in this connection. The coefficient of the reflection is investigated by a diagram which is similar to that of the reflection loss.

Author.

**25. A Null Method for Testing Magnetic Properties of Materials** (Japanese). **Yasujirō NIWA**. [J. I. E. E. Japan, **435** (1924), 929-953, with fig.]—A description is given of the theory, the construction and the operation of the permeameter devised by the author, and also of some experimental studies upon it. The permeameter is a double bar and double yoke type. The reluctance of the yoke and gaps is compensated by the magnetising coils on the yoke which are excited and regulated independently. The criterion of the proper compensation is the condition that the magnetomotive force applied between two fixed points in the specimen is exactly consumed by the magnetic reluctance of the section. This condition is confirmed by proving that the magnetic potential difference between these two points is zero.

Experiments show that the permeameter gives satisfactory results in the measurement of the magnetic properties of solid and sheet materials of iron and steel. The accuracy and the consistency of the readings taken at different times exceed all that is required in most commercially precise magnetic measurements.

Author.

**26. Inductances of Polygonal Coils** (Japanese). **Issaku KOGA**. [J. I. E. E. Japan, **435** (1924), 954-977, with fig.]—The author discusses the inductances of triangular, hexagonal and octagonal coils, with some calculations of the mutual inductances between two linear conductors in general, assuming the permeability of the medium to be always unity throughout the space. The chief merit of the formulae is their accuracy even for a small number of turns and a considerable length of pitch. Tables of constants in the formulae are furnished.

M. H.

**27. Magnetic and Electric Properties of Electrolytic Iron and Alloys Melted in Vacuo and Rolled into Sheet**. **Masaru FUKUDA**. [J. I. E. E. Japan, **435** (1924), 978-1007, with fig.]—The author investigates the magnetic and electric properties of electrolytic iron and its alloys melted in vacuo and rolled into sheets. The experiments were carried out in D. C. and A. C. ring methods; in the latter case, the author used a synchronous commutator to determine the mean value of E. M. F. induced in the secondary circuit wound on the test ring. The results show that the permeability of the sheets exceeds by about 20% that of the Roy or Stalloy. The author finds that the retentivity of sheets made of aluminium alloy is very small.

M. H.

**28. On the Behaviour of the Triode Valve under the Influence of Magnetic Field** (Japanese). **Heichi NUKIYAMA**. [J. I. E. E. Japan, **436** (1924), 1041-1057, with fig.]—The triode valve in which the filament and the plate constitute coaxial cylinders was chosen and a magnetic force parallel to the filament was applied.



The static characteristics were greatly modified and the maximum plate current were observed. The grid current becomes a maximum when the magnetic force is intermediate between the critical magnetic forces for the grid and the plate. The theoretical explanation and an example of the application of the phenomena are given. Author.

**29. On the Surface Discharge of Electricity on Insulating Materials** (Japanese). **Shigeo MOCHIZUKI**. [J. I. E. E. Japan, **436** (1924), 1058-1067, with fig. and pl.]—The surface discharge of electricity over solid insulating materials is investigated by means of photographic plates and films in the following cases.

(1) In air. Various insulating plates are used, and tests are made under a number of different conditions such as momentary application of electric potential and electric oscillations damped or sustained. Under 50 cycle a. c. voltage, it is found that there is a certain critical voltage which changes the nature of discharge, i. e. under the voltage, the luminous pole-brush, and over the voltage, the spark-corona.

(2) In transformer oil. A distinct pole-brush cannot be observed and the difference of the positive and negative surface-spark-corona is not so distinct as in air. By making microscopic investigations of the images on the photographic films, it is ascertained that the sensitive film has no important effect on the nature of discharge. Author.

**30.  $K$ - $M$  Chart—A Computation of Electromagnetic Induction between Aerial Line and other Neighbouring Circuits** (Japanese). **Ryōtarō MITSUDA** and **Kan KASAI**. [Researches, Electrot. Lab. Tokio, Japan, **133** (1924), 1-23, with fig.]—A convenient chart is introduced to compute theoretically the voltages induced electromagnetically in the aerial line by neighbouring electric currents. It is derived by a mathematical treatment with the consideration of an equivalent earth plane, and shows the relation between the voltage  $K$ , induced per unit length per ampere of inducing current, and a factor  $M$ , representing the mean separation of the circuits. The chart is conventionally called  $K$ - $M$  chart associated with the authors' names. Authors.

**31. Experimental Determination of Fundamental Dynamic Characteristics of a Triode.** **Eijirō TAKAGISHI**. [Researches, Electrot. Lab. Tokio, Japan, **134** (1924), 1-15, with fig.]—A method of measuring fundamental harmonic in distorted electric current is adopted to determine the dynamic characteristics of a triode. The experiment is confined to a special case, where grid and anode voltages are kept just in opposite phase. The circuitual arrangements of the measurements are fully described. Some of the fundamental dynamic characteristic curves of a triode thus determined are shown and explained. It is found that the anode current and grid voltage characteristic curve has a falling region in a working condition and that the current which flows through the grid circuit generally amounts to an enormous value. The phenomenon of "Ziehen" in the operation of a triode as an oscillator is also briefly mentioned. It is observed that a voltage amplification factor according to the present definition is not of constant value, but is subjected to variation with applied voltages. A new constant is proposed, which relates to the emission current from the incandescent cathode of a triode instead of to the anode current. M. H.

**32. Theory of an Electromagnetic Moving Coil Type Oscillograph.** **Saburō NUMAKURA.** [Researches, Electrot. Lab. Tokio, Japan, **135** (1924), 1-73, with fig.]—The author investigates theoretically the motion of the vibrator taking the mirror as a rigid body and the strips as elastic substances. To establish the equation of motion, the author considers the kinetic energies, potential energies, and the work done due to the applied and resisting forces of the vibrator, and then obtains the equation of motion by the principle of the "virtual displacement". To solve it, the amplitude of any point of the strips which is a function of time and applied E. M. F. is expanded by Fourier's series. Author.

**33. High Frequency Telegraphy and Telephony** (Japanese). **Noboru MARUMO.** [Researches, Electrot. Lab. Tokio, Japan, **136** (1924), 1-293, with fig.]—The former half of the paper deals with the technical details of the carrier current telephony, especially on a power transmission line, regarding the adjustment of resonant transmission line circuit, signalling apparatus, protecting devices, methods for superposing oscillation to the normal current of a line, etc. Experimental results at the Fuji Hydro-Electric Co. are given. In the latter half, the resonant frequencies of the line circuit, and the distribution of current and voltage along the line are discussed theoretically from the fundamental equation of Heaviside for current and potential distribution on a parallel line. Resonant frequencies were actually measured on the lines, which were 533 m. and 10,023 m. long, and when undamped oscillation current of resonant frequencies is applied to the lines, it is shown that stationary waves are excited. The experimental results coincide well with the established theory. It is added that the method of resistance measurement which is done by inserting a non-inductive resistance in a circuit and by reading the corresponding variation of current is not applicable to the case of a resonant line circuit along which oscillation is in a stationary state. M. H.

**34. Synchronous Operation of Two Alternators through Unsymmetrical Impedances.** **Sadatoshī BEKKU.** [Researches, Electrot. Lab. Tokio, Japan, **138** (1924), 1-11, with fig.]—The author shows the method of calculation for the synchronizing power and the coupling angle, when two alternators are running in synchronism through unsymmetrical impedances. In special cases the results coincide with those deduced from the proposition of Prof. Nishi of the Tokio Imperial University. The method is applied to determine the mode of transposition of the transmission line of Tokio Electric Light Co. in order to obtain satisfactory operating results. Author.

**35. Mercury Arrester** (Japanese). **Kan KASAI and Hideo TAKAGISHI.** [Researches, Electrot. Lab. Tokio, Japan, **139** (1924), 1-35, with fig. and pl.]—The mercury lightning arrester—a low voltage arrester for weak current lines developed by the Third Section of the Electrot. Lab., Ministry of Communications, Tokio, Japan, in charge of Dr. R. Mitsuda,—is essentially a spark gap with mercury electrodes in a partial vacuum of a certain gas. The principal merits of this arrester are: (a) discharge voltage is low (about 250 volt), and its action is sure; (b) discharge capacity is large and durable; (c) it is self-restoring and the condition of the gap is not affected even by a heavy discharge; (d) the discharge gap is not affected by external causes, such as moisture, dust, insects, etc.; (e) discharge is observable, and inspection

is easy. Since 1919 about 250 mercury arresters have been tested by installation on several communication lines. Some of these communication lines pass through comparatively severe lightning districts and some run closely in parallel to large extra-high tension transmission lines, either on a separate route or on the same supports. By extended experiments it has been found that the protective capacity of the mercury arrester under test is about 99.5% for the total number of about 2,900 cases of high voltage disturbances.

Author.

**36. *Organic Accelerators, Part II*** (Japanese). **Shukusaburō MINATOYA** and **Shun-ichi FUKUDA**. [Researches, Electrot. Lab. Tokio, Japan, **140** (1924), 1-26.]—The constituents of various organic accelerators on the market are investigated. In consideration of their desirable characteristics, the authors recommend the employment of ultra accelerators for electric wire insulation, and by careful analysis they confirm that the effective constituent of Xanthopone is Zinc Xanthogenate; that of Super Sulphur No. 1 is zinc dithiocarbamate; that of Super Sulphur No. 2 is lead dithiocarbamate; that of Vulkacit P is pentamethylene piperidyl dithiocarbamate, respectively, and also that these effective constituents are all ultra accelerators.

Authors.

**37. *A Study of Coils Wound on Rectangular Frames with Special Reference to the Calculation of Inductances***. **Yasuiirō NIWA**. [Researches, Electrot. Lab. Tokio, Japan, **141** (1924), 1-104, with fig.]—The writer obtained formulæ for coils wound on rectangular frames and for the mutual inductances of two square solenoids. The errors involved in the calculation of self and mutual inductances by substituting for the square or rectangular solenoids circular or square ones have been examined. The mathematical formulæ obtained are based on the assumption of the current sheet distribution, and the range of the practical applicability of these formulæ to the actual coils has been studied, besides the method of correction to take into account the concentration of current in the wire. Formulæ for the calculation of the self inductance of square coils with rectangular winding section have been derived with proper approximation. Also some applications, in which the self or mutual inductances of coils are obtained by combining the fundamental formulæ of self and mutual inductances, have been explained. Numerous tables and curves have been prepared for the purpose of facilitating the actual calculation.

Author.

**38. *Some Researches on Electrical Insulating Materials*** (Japanese). **Yoshisaburō OGAWA**, **Tatsurō HANIU** and **Katsuhide NISHIUCHI**. [Researches, Electrot. Lab. Tokio, Japan, **143** (1924), 1-24, with fig.]—

(1) On the electrical uses of squalene hydrocarbon.—Squalene, when dried alone, is proved to be too brittle for insulating varnish, but when boiled linseed oil is mixed with it in different proportions its toughness and flexibility are increased. The most suitable proportion of the boiled oil is found to be 1—2 to 1 of squalene. The oil-squalene varnish dries in 3 hours when heated to 110°C., lead or manganese driers being used, and has a break-down voltage of 1,000—1,500 volts per mil. No special merit of squalene is recognized as compared to ordinary oil-resin type insulating varnishes. Squalene partially hydrogenated with the aid of nickel-catalyser is a non-drying liquid and can be used as an insulating oil. It has a flash point of 175°C., Redwood viscosity 100 second at 30°C., break-down voltage 40 kilovolts for 0.15 inch gap, a very low

freezing point and good endurance properties. It is free from sulphur or other mineral impurities.

(2) The deleterious effect of fibres on insulating varnish.—The deleterious effect of fibres on the insulating power of transformer oil was brought to light by Hirobe, Ogawa and Kubo in 1916. A similar conclusion as to the effect of fibres in insulating varnish is made by the present authors. Dielectric strength of a varnish film contaminated with a very small amount of fibres is easily brought down to  $1/3$  or less in comparison with the pure film free from fibre. Insulation resistances of the pure varnish film and films containing fibres in different quantities are also measured. The authors point out the importance of cleanliness in varnish making, and also suggest some useful points in the manufacture of insulating oil-paper and empire cloth.

(3) The hardening effect of picric acid on phenol resin.—The authors have discovered that picric acid exercises a remarkable accelerating effect on the hardening of phenol resin. Only a small quantity of picric acid, mixed to oily phenol-formaldehyde condensation product made with NaOH as catalyst, is enough to harden the resin in one hour. The use of picric acid is recommended to make a quick drying phenol-resin insulating varnish.

Authors.

**39. Further Study on the Magnetic Properties of Electrical Sheet Steel under Superposed Alternating Field and Asymmetrical Hysteresis Losses.** Yasujirō NIWA, Jōji SUGIURA and Jirō MATSUURA. [Researches, Electrot. Lab. Tokio, Japan, 144 (1924), 1-45, with fig.]—Continuation of the former research by the same authors (Researches of the Electrot. Lab. No. 124, 1923). The magnetic properties of sheet steel under superposed magnetic pulsation with sinusoidal exciting current are investigated. Also the hysteresis losses under such conditions are determined. It is shown that the hysteresis loss, the amplitude of pulsation of the magnetising force, and the constant magnetising force have linear relations among themselves within a certain range of magnetising forces. Dynamic hysteresis loops are obtained by means of the cathode ray oscillograph. Through the accuracy of the experiments it is shown that the variation of the magnetic characteristics of iron by superposing pulsating magnetic flux is due to the magnetising or demagnetising effects of pulsating flux.

Authors.

**40. Transmission Characteristics of Coil Loaded Telephone Cables.** Kazukiyo OGAWA. [Researches, Electrot. Lab. Tokio, Japan, 145 (1924), 1-17, with fig.]—Transmission characteristics of coil loaded telephone cables are discussed. An approximately equivalent circuit of the coil loaded cable is then derived, and it is shown that the assumption that the capacity of the cable between two consecutive loading coils is concentrated at the middle point of the cable leads sometimes to results containing considerable errors. Especially the attenuation constant of the loaded cable within the range of frequencies lower than the cut off frequency is accompanied by considerable errors if computed on the above assumption. A numerical example is given for the loaded cable between Tokio and Yokohama which is the standard medium heavy loaded cable of the Western Electric Co.

Author.

**41. On Electrical Tabulating Machines (Japanese).** Yasujirō TAKAHASHI and Shigeo SHŌJI. [Researches, Electrot. Lab. Tokio, Japan, 146 (1924),



1-13, with fig. and pl.]—The authors describe the general feature of electrical and mechanical arrangements adopted for the electrical tabulating machines designed by them. The machines are capable of making the tabulations of any three sorts of items on a perforated card simultaneously, at the speed of 120 cards per minute.

M. H.

**42. On the Breakage of an Aereal Transmission Line** (Japanese). **Sadatoshi BEKKU** and **Koichirō MAEKAWA**. [Researches, Electrot. Lab. Tokio, Japan, **147** (1924), 1-25, with fig.]—This paper deals with the mechanical characteristics of the breakage of an aerial transmission line and shows a fundamental equation, by means of which the final displaced condition, arrived at after the oscillatory swing caused by the break of the line conductor, may be obtained. Starting from the well-known parabolic equation of a span wire, the fundamental equation is derived from a linear differential equation of the second order. When an anchor tower is far away from the broken span, the solution becomes very simple. In the actual tests of the breakage of line at the Jōetsu transmission line of the Tokio Electric Light Co., the slipping of the line conductor at the support due to the unbalanced tension has been prevented by using a special clamp. The tests have been executed in the two cases (1) when the break of the span wire occurs at the farther end of the support so that the wire hangs down to the ground, and (2) when the break occurs near the support with no slack wire to hang down. Measurements have been made for the swing of insulator string, the height of dip vertex above the ground, the horizontal displacement of dip vertex, and the deflection of tower arm. By means of the test results thus obtained, the maximum dip of conductors, the unbalanced tension, the inclination of insulator string, the shortened span, etc. have been found. Moreover, two cases are shown with examples, in which the support of line at the insulator string, with or without a jamper wire, fails, with the result that the dip slackened in the span and tension tightened in the consecutive spans.

Authors.

**43. Geometrical Calculation of Illumination due to Light from Luminous Sources of Simple Forms.** **Jirō YAMANOUCHI**. [Researches, Electrot. Lab. Tokio, Japan, **148** (1924), 1-30, with fig.]—The illumination can be considered vectorially and the component illuminations enable us to calculate easily the illumination in the space. The author calculates the component illuminations due to the light from luminous sources of various forms under several reasonable assumptions. The correction factors,  $C$ , to be multiplied to the values given by the inverse square law are calculated for the illumination whose direction is towards the geometrical centre of the source. The total flux falling on a certain disc emitted from the source is obtainable by using these component illuminations. When both the source and the receiving surface can be considered as two circles on the same sphere, the total flux falling on the disc emitted from the source can be easily calculated.

Author.

**44. Further Study on the Design of Induction Type Watt-hour Meters.** **Seikichi JIMBŌ**. [Researches, Electrot. Lab. Tokio, Japan, **149** (1924), 1-40, with fig.]—The author derives a general formula for the torque, supposing that the boundary of the disc is a square or a rectangle. A discussion is given on the relation between the torque and the construction constants of the meter for the special

case where the magnetic inductions are uniformly distributed under the magnetic poles. A method of design in this special case is presented with a numerical example.

M. H.

**45. On the Temperature Rise of Lamp Sockets** (Japanese). **Matsujirō ŌYAMA**. [J. Ill. Eng. Soc., VIII., 1 (1924), 43-54, with fig. and pl.]—The temperature rise of lamp sockets is partly due to ohmic loss produced in their mechanism, but chiefly to the heat generated in the lamp filaments. Hence it is much affected by the attached lamp and shade. Series of tests are carried out for various combinations of several kinds of lamps and two typical shades, and their results are shown.

Author.

**46. On the Brightness of Frosted Lamps and Several Kinds of Luminaires** (Japanese). **Shigehiro SEKI**. [J. Ill. Eng. Soc., VIII., 1 (1924), 55-64, with fig.]—The author measures the brightness of frosted lamp bulbs, globes and semi-indirect bowls, and obtains the following relations. The brightness of frosted bulb surfaces increases with the increase of the rated capacity of the lamp. For semi-indirect bowls and opal globes, the surface brightness is proportional to the spherical candle power of the lamp, and inversely proportional to the square of the diameter. For the ordinary frosted glass globes the above relations do not hold strictly.

Author.

**47. On Electric Heating Apparatus** (Japanese). **Shin-ichi OTOBA**. [J. Ill. Eng. Soc., VIII., 3 (1924), 244-250, with fig.]—The author gives data on the relation between the electrical energy and heat energy of electrical heaters, and determines the capacity of electrical heaters. The effect of humidity is also considered.

Author.

## MINE ENGINEERING (1—16).

1. *An Investigation upon the Precipitation of Hematite with Special Reference to the Study of Ōmori Ore Deposit* (Japanese). **Mikio KUHARA**. [Nihon-Kōgyōkwaishi, Ser. XL., 473 (1924), 561-566.]—The author has shown experimentally the precipitation of hematite from the low-temperature ascending spring in the presence of certain minerals such as calcite, siderite, etc., being excluded from the action of air. With this experimental result he has investigated the formation of hematite at the Ōmori ore deposit. H. S.

2. *Tests on Air Compressors at Japanese Mines* (Japanese). **Hidesaburō AOYAMA**. [Nihon-Kōgyōkwaishi, Ser. XL., 476 (1924), 823-865, with fig. and tables.]—True volumetric and mechanical efficiencies of air compressors are numerically observed for the latest compressors which are installed at Japanese mines. Moreover, several precautional reviews on the temperature, and also on the explosion of air compressors, with special relation to the altitude of the location, are discussed. Author.

3. *On the Flotation Oil* (Japanese). **Kojirō KAWAMURA**. [The Suiyō-Kwaishi, IV., 7 (1924), 1004-1051, with fig., phot. and tables.]—The author has obtained experimentally the following observations upon the action of the flotation oil:—(1) Lighter oil obtained by low-temperature distillation is generally suitable for frother and heavy oil obtained by high-temperature distillation for collector. (2) Lower viscosity and surface tension tend to favour frothing and higher to favour collecting. (3) Action of air and sunlight seems to increase the collecting power of oils. (4) Treatment of oil with sulphuric acid favours frothing. Soluble portion of oil in alkaline solution is suitable for frothing agent. (5) Solubility of oil in water favours frothing. (6) Deflocculating agent retards frothing. (7) Consumption for collector is more than that for frother. (8) The floating of minerals starts from fine grains. H. S.

4. *Treatment of Slack* (Japanese). **Hidetoshi MATSUNAMI**. [The Suiyō-Kwaishi, IV., 7 (1924), 1105-1137, with fig. and tables.]—The author has studied experimentally the treatment of slack finer than 200 meshes. The drying can be advantageously preceded by concentration. The concentration by flotation process is recommended. The camphour blue oil from Formosa as flotation agent gives satisfactory results. The result of testing concentrate briquette is also given. H. S.

5. *Method of Testing Fire-Damp by Means of a Safety-Lamp* (Japanese). **Hidenosuke SANO**. [Monthly Rep. C. C. M. A. Japan, XX., 242 (1924), 714-722, with fig. and tables.]—The author has compared experimentally the normal with the reduced flame as testing flame for fire-damp. He has found that the normal flame must be safer than the reduced one, but the difference is so small that no effect can be recognized upon the safety of the Wolf naphtha lamp. Author.

6. *On the Natural Gases containing Helium in Japan* (Japanese). **Kunio UWATOKO**. [J. Geol. Soc. Tokyo, XXXI., 371-2 and 373-4 (1924), 289-303

and 340-356, with fig. and tables.]—The author has investigated natural gases obtained from different geological formations in Japan. In one case 0.2% of helium was detected in natural gas. The effect of volcanic action upon the content of helium, and the relation between nitrogen and helium contained in natural gases, are discussed in detail.

H. S.

**7. *The Gob-Fire and the Pressure of Mine Air*** (Japanese). **Hidenosuke SANO**. [Kyûshû-Kôzan-Gakkwaishi, I., 3 (1924), 224-233, with fig. and tables.]—The author has shown experimentally that the variation of the pressure of mine atmosphere has a larger effect on the air current in goaf than on that in roadways, which tends to induce the gob-fire. The velocity of air current in roadways is approximately proportional to the square root of the air pressure, but in goaf directly to the pressure.

Author.

**8. *Notes on Relations between the Output and the Development of a Mine*** (Japanese). **Hidekane TOYODA**. [Nihon-Kôgyôkwaishi, Ser., XL., 470 (1924), 329-373, with fig.]

**9. *Some Tests upon Various Rock Drills*** (Japanese). **Shûichirô SATÔ**. [Nihon-Kôgyôkwaishi, Ser., XL., 476 (1924), 866-875, with fig.]

**10. *Tests for Determining the Width of Centrifugal Mine Fans*** (Japanese). **Einosuke MIKUMO**. [Nihon-Kôgyôkwaishi, Ser., XL., 473 (1924), 566-581, with fig. and tables.]

**11. *Determination of Frictional Resistance of Mine Tubs*** (Japanese). **Seishin MIZUTANI**. [The Suiyô-Kwaishi, IV., 5 (1924), 623-639, with fig.]

**12. *Some Studies upon the Constitution of Japanese Coal*** (Japanese). **Kunihiko YAMADA**. [The Suiyô-Kwaishi, IV., 6 (1924), 839-847, with phot.]

**13. *Microscopical Study of Ores*** (Japanese). **Ginjiro KURAUCHI**. [The Suiyô-Kwaishi, IV., 6 (1924), 913-928, with fig.]

**14. *Relations between Equivalent Orifice of a Mine and Size of the Fan, and Results of Combined Running of Two Fans*** (Japanese). **Fumio ODA**. [Monthly Rep. C. C. M. A. Japan, XX., 235 (1924), 21-44, with diag. and tables.]

**15. *Gallery-Tests of Safety-Explosives at Naogata Experimental Station*** (Japanese). **Toyotami NISHIMUDA**. [Kyûshû-Kôzan-Gakkwaishi, I., 3 (1924), 208-224, with tables.]

**16. *Washing-Tests of Slack by Rheolaveur*** (Japanese). **Yôichi OKADA** and **Fukusaburô YAMAMOTO**. [Kyûshû-Kôzan-Gakkwaishi, I., 3 (1924), 249-260, with fig. and tables.]



## METALLURGY (1—50).

1. *On Reduction of Iron Oxide and Iron Ores by Hydrogen* (Japanese). **Heihachi KAMURA**. [Tetsu-to-Hagane, IX., 10 (1923), 699-708, with diag. and fig.]—The reduction of iron oxide by hydrogen takes place already at such a low temperature as 200°C., and its speed suddenly increases between 440° and 770°C. The speed increases with the temperature, but the progress of reduction differs according to the temperature. In the case of hematite its reduction speed considerably increases with the temperature, being slow under 500°C., and rapid between 550° and 600°C. H. G.

2. *Investigations of Ternary Alloy System of Copper Aluminium and Nickel* (Japanese). **Ichirō IITAKA**. [Tetsu-to-Hagane, X., 1 (1924), 1-33, with diag. and phot.]—The solidifying phenomena and the constitutional change after solidifying of Cu-Al-Ni ternary alloys were investigated. In Cu-Al binary system,  $\beta$  and  $\delta$  constituents do not completely dissolve even at a high temperature, but by adding an amount of Ni above 40% they completely dissolve at any temperature. On the melting surface of the ternary system, 2 curves meet at one eutectic valley. The constitutional diagrams at the solidifying temperature, 900°C. and 500°C., were obtained through this investigation. H. G.

3. *Investigations of Nickel and Chrome Steel* (Japanese). **Hareto KIKKAWA**. [Tetsu-to-Hagane, X., 2 (1924), 69-124, with diag. and phot.]—The change of transformation point  $A_c$  is due not only to chrome, but also to cooperated action with carbon or chrome-carbonate. By adding nickel to steel, its self-hardening effect is distinctly increased with even a small amount of Cr. The shock test of steel containing Cr was proved to be good when it was annealed at about 700°C. or below the transformation point. Also it was ascertained that the practical tempering temperature of the ordinary tough materials for machinery use was between 600°C. and 650°C. A little addition of Ni and C (say 0.85% Ni; 0.53% C) to chrome steel containing 1% of Cr is sufficient to give a self-hardening property. If the martensite crystal be made as small as possible by lowering the quenching temperature, the shock test shows good results. H. G.

4. *On Reduction of Iron Ore by Carbon Monoxide—In the Presence of Steam* (Japanese). **Masana KAWANA**. [Tetsu-to-Hagane, X., 2 (1924), 125-128.]—By the reduction of iron ore at low temperature steam is decomposed and generates H<sub>2</sub> and CO<sub>2</sub> gases in the presence of CO gas. The reduction velocity of the iron ore is quickest at the period when Fe<sub>3</sub>O<sub>4</sub> is formed, and the generation of hydrogen is small. At a later stage, however, the reduction velocity gradually decreases with increasing H<sub>2</sub> and CO<sub>2</sub> gases. When the hematite is reduced at a low temperature, say 400°C., a considerable quantity of carbon is deposited; however, in the presence of steam, this action is mostly prevented. The degree of catalysis varies according to the kind of ores; limonite acts as a catalyser more strongly than hematite. H. G.

**5. On Metallikon** (Japanese). **Yoshihiro KAWAKAMI**. [Tetsu-to-Hagane, X., 3 (1924), 147-152, with fig. and phot.]—The metal grain has a tendency to solidify in course of emission, but seems to remelt on the surface of the substance to be coated as the result of collision, and thereby adheres better than a mechanical coating. When metals such as zinc and iron are used, they seem to form an alloy at the surface, so that the resistance to stripping further increases. As the metal grain is cooled by the emission of gas, even wood, paper and cloth do not burn. As to the oxidation of the metallikons, silver metallikon suffers the least effect, aluminium the greatest; copper and brass change their colour, and zinc and tin are oxidised to a fair extent.

H. G.

**6. On Fluidity of Molten Metal** (Japanese). **Kennosuke HAYASHI**. [Tetsu-to-Hagane, X., 3 (1924), 159-166, with diag. and fig.]—Various molten metals were casted in a long canal and their fluidity observed. Every metal suddenly increased its fluidity at about 100°C. above its melting point; beyond that the fluidity increased slowly, and some metals, such as aluminium, showed a decrease in rising temperatures, which was probably due to oxidation. The effect on the fluidity of impurities, and also of the formation of alloys with other metals, is also considered.

H. G.

**7. Investigations of Nickel-Chrome Steel** (Japanese). **Hareto KIKKAWA**. [Tetsu-to-Hagane, X., 3 (1924), 179-189, with diag. and phot.]—By adding 1.5 per cent. of nickel to high chrome stainless steel, its hardness and tenacity become superior to those of ordinary tenacious Ni-Cr steel, at 800°C. the former being harder than the latter. By water or oil quenching at 1200°C., all parts of the metal are transformed into austenite. The tenacity of this material is greater than that of common steel. Its elongation and shock tests prove to be satisfactory.

H. G.

**8. On the F. W. Permanent Magnet Steel** (Japanese). **Saburō WATANABE**. [Tetsu-to-Hagane, X., 5 (1924), 287-292, with diag.]—This paper deals with the F. W. self-hardened permanent magnet steel which contains C, 0.6-1%; Cr, 2-5%; and Mn, 1-4%. This steel is shown to be better than ordinary tungsten magnet steel. By a proper control of the amount of Cr and Mn, it can be made self-hardened and freed from difficulties met with in quenching.

H. G.

**9. On a New Alloy as a Material for Turbine Blades** (Japanese). **Ichirō IITAKA**. [Tetsu-to-Hagane, X., 7 (1924), 449-462, with diag. and phot.]—An alloy consisting of 85 or 90 per cent. copper and some nickel and aluminium has nearly the same mechanical properties as the monel metal, and its toughness resembles that of nickel steel. This alloy becomes soft by quenching and hard by annealing. The tenacity is higher than that of ordinary copper alloys. This alloy is hardly corrosive in acids, alkalis, sea water and H<sub>2</sub>S gas. Thus the metal will be the most suitable material for turbine blades and steam valves, which are subjected to a high temperature, and also for springs and toothed wheels which are to be used in places where high resistance to corrosion is desirable.

H. G.

**10. Experiments on heated Gun Metal and Phosphor Bronze Castings** (Japanese). **Eisuke TANIYAMA**. [Tetsu-to-Hagane, X., 7 (1924), 462-471, with diag., phot. and tables.]—Some of these alloys are harder at a certain temperature

than at the ordinary temperature. While phosphor-bronze is very strong at 400°C., its strength suddenly decreases at a temperature above that. The strength of gun metal steadily increases until 300°C. and then gradually decreases.

H. G.

**11. On the Relation of the Dimensions and Elongation of Test Pieces, Part III. Forged Steel** (Japanese). **Kajima MUROI**. [Tetsu-to-Hagane, X., 7 (1924), 472-474, with diag.]-In spite of the different tensile properties of the two forged steels used in this investigation, curves showing the relation between the ratio of elongation and  $\frac{\text{gauge length}}{\sqrt{\text{sectional area}}}$  agreed with each other.

H. G.

**12. On Reduction of Iron Ores, Part I** (Japanese). **Heihachi KAMURA**. [Tetsu-to-Hagane, X., 7 (1924), 475-489, with diag., fig., phot. and tables.]-Proper reduction temperatures of several kinds of iron ores were determined by experiment.

H. G.

**13. Investigations of Iron Sand** (Japanese). **Shichizō UMEZU**. [Tetsu-to-Hagane, X., 8 (1924), 519-542, with diag., fig. and phot.]-The iron sand in Japan is the mixture composed of pure magnetite grains, pure ilmenite grains, their eutectic-structured grains and grains of their solid solution. The natural iron sand contains 6 or 8% of titanium, and presents a special latticed structure. The same substance was artificially obtained by melting oxides of iron and titanium with an electric arc.

H. G.

**14. On the Relation of the Dimensions and Elongation of Test Pieces, Part IV. Rolled Copper Bars** (Japanese). **Kajima MUROI**. [Tetsu-to-Hagane, X., 8 (1924), 554-557, with diag.]-The author made an investigation to find the relations between the elongation of copper bars of the Japanese standard test piece and that of bars used now in the Naval Ordnance and Ship Construction Department. For copper the length of the parallel part of the test pieces has been found to have a conspicuous influence upon the elongation. Owing to this fact, the relations between the elongations of these two kinds of test pieces could not be ascertained conclusively. It is likely, however, that the elongations are nearly equal, the ratio between the elongation of the former to that of the latter being nearly 1:0.97.

H. G.

**15. On Inverse Segregation in Bronze** (Japanese). **Kanji MATSUYAMA** and **Hiroshi IHOKIBE**. [Tetsu-to-Hagane, X., 9 (1924), 599-612, with diag. and fig.]-It was found that the quicker was the cooling, the more remarkable the inverse segregation was. It will take place parallel with the solidifying region of the alloy.

H. G.

**16. On Cutting Efficiency of Japanese Swords** (Japanese). **Shirō ISHIDA**. [Tetsu-to-Hagane, X., 10 (1924), 660-693, with diag., fig., phot. and tables.]-The experiment was made to discover the relation between the external form of Japanese swords and the efficiency of the cutting when the sword is used impulsively. Ideally the angle of the sword blade should be 0°; actually, however, some angle should be allowed for obvious reasons. Some curvature in the form of swords should be made in order to obtain the higher efficiency.

H. G.

**17. On Temper Brittleness of Steel** (Japanese). **Hareto KIKKAWA.** [*Tetsu-to-Hagane*, X., II (1924), 723-759, with diag., fig., phot. and tables.]—The temper brittleness of steel occurs most markedly in Cr-Ni-steel, moderately in Cr-steel, Ni-steel, C-steel, and very little in steel which contains rare metals such as Mo and Va. Experiments show that steel which contains Mo suffers no temper brittleness, while that containing Va has a slight tendency towards it. This brittleness can be removed by a quick cooling after tempering; to remove it by slow cooling, super-oxidation must be prevented or a special element such as Mo and Va added. In making alloy steels, injurious elements, especially oxygen, must be excluded. When cooling from the annealing temperature, a quick cooling must be made between 600°C. and 400°C., and the tempering temperature for remedying quenching stress must not be over 550°C.; the steel heated at this temperature is always brittle, whatever be the rate of cooling.

H. G.

**18. Theoretical Investigations on the Construction and Operation of the Cupola Furnace** (Japanese). **Masaya HIRAOKA.** [*Tetsu-to-Hagane*, X., II (1924), 739-759.]—The relation between the blast pressure and the furnace height, and the ratio of the sectional areas of the tuyere to the furnace sectional area, have an important bearing upon the smelting capacity. According to the author, the smelting capacity can be represented by the following formula:—

$$\text{The Smelting Capacity} = K \frac{\sqrt{P} A}{\sqrt{A} l_c}$$

where  $P$  is the pressure of the blast,  $A$  the furnace area,  $l_c$  the percentage of coke to metal, and  $K$  a constant. Experimentally it was determined that the value of  $K$  was nearly 105 under proper conditions.

H. G.

**19. On Properties of Roasted Ores** (Japanese). **Jitarō YONEZAWA.** [*Nihon-Kōgyōkwaishi*, Ser. XXXIX., 464 (1923), 710-713, with diag. and tables.]—The properties of the cinder from sulphide ore were examined with a view to its utilization. Its copper content seems to have an intimate relation with sulphur, and iron has a tendency to separate easily from sulphur. By magnetic treatment it was found that the roasted ore containing copper, and the purple ore from which copper was extracted, had strong magnetic properties. It is important to observe that by magnetic separation much copper and sulphur are contained in the concentrate, and little in the tailing.

H. G.

**20. On the Al-Cu-Sn Alloys of High Aluminium Content** (Japanese). **Masaharu GOTŌ and Tokushichi MISHIMA.** [*Nihon-Kōgyōkwaishi*, Ser. XXXIX., 464 (1923), 714-721, with diag., phot. and tables.]—In regard to Al-Sn alloys, contrary to Gwyer's view Al makes a solid solution by dissolving 2 per cent. of Sn. It was shown that Al dissolved Sn but did not make any solid solution. As to Al-Cu-Sn alloys, their hardness at high temperatures at one time suddenly increases (say at about 200°C.), but again decreases quickly; this seems to be due to the transformation of Sn at 200°C. The decrease of hardness at 230°C. may be attributed to the fact that Sn is absorbed in the alloy neither as a solid solution nor as a compound, but exists as an eutectic.

H. G.



21. *On the Calculation of Economical Current Density in Electrolysis* (Japanese). **Keinosuke HIRAKOSO**. [Nihon-Kôgyôkwaishi, Ser. XL., 469 (1924), 267-287, with diag. and tables.]—A formula for calculating economical current density is derived, electric power, redemption-fund, interest, loss of gold and silver, labour costs and interest on metals in arrears being taken into consideration, and the minimum operating cost is determined in terms of these items. H. G.

22. *On Low Temperature Distillation of Coal and the Application of Zinc* (Japanese). **Kennosuke TSUJIMOTO**. [Nihon-Kôgyôkwaishi, Ser. XL., 470 (1924), 373-386.]—It is aimed to keep coal in contact with a certain catalyser which has a large heat capacity and which can be kept at a fixed temperature. For this purpose, zinc may be utilized. Metallic zinc melts at 420°C., volatilizes at 930°C. and is not difficult to keep at any definite temperature between these points. The distillation is completed in a very short time if a proper vessel filled with lump coal or briquette coal is put into a molten zinc bath. H. G.

23. *On Alloys of Lead and Antimony* (Japanese). **Kyôsukey KANEKO** and **Moritarô FUJITA**. [Nihon-Kôgyôkwaishi, Ser. XL., 471 (1924), 439-449, with diag., phot. and tables.]—It was found that two kinds of the solid solutions  $\alpha$  and  $\beta$  existed at both extremes of antimony content, say from 0% to 5%, and from 97% to 100%. In the equilibrium-diagram of this alloy, an arrest-line was located at 243°C. in the range from 30% to 97% of antimony, and an unstable compound  $Sb_3Pb$  was recognised at that point. The hardness at the extreme point of the solid solution of Sb, (5 per cent. in content) increases slowly but at 97 per cent. of Sb it decreases suddenly and there is a point of sudden change at 63 per cent. of Sb in the hardness curve. The solubility of this alloy to acids increases with the addition of the other component, and reaches the max. point at 45 per cent. of Sb in the alloy, between them two scarcely soluble points being observed. H. G.

24. *On Aluminium-Tin Alloys* (Japanese). **Kyôsukey KANEKO** and **Miyoichi KAMIYA**. [Nihon-Kôgyôkwaishi, Ser. XL., 472 (1924), 509-516, with diag., phot. and tables.]—The equilibrium-diagram of Al-Sn alloy was completed and its eutectic point was found to be at 1.3% Al and 98.7% Sn. The hardness of this alloy is maximum at 5% Sn; and on approaching to pure tin, it decreases suddenly. Its specific gravity increases with the content of tin. This does not differ much from the calculated value, and shows that there is no special expansion or contraction, whatever be the proportions. With regard to the solubility to acids, the max. solubility occurs at 5% of Sn, and then gradually decreases as the Sn content increases, pure tin being practically insoluble. H. G.

25. *On Blast Furnace Smelting with Pulverized Coal* (Japanese). **Keinosuke YABE**. [Nihon-Kôgyôkwaishi, Ser. XL., 474 (1924), 657-695, with fig. and tables.]—At the Hidachi Copper Mine, pulverized coal is used instead of tuyere coal in the blast furnace. The pulverized coal is made of black lignite of poor quality from the Jôban district, mixed with some small amount of coal of good quality. The pulverizing apparatus used is the Holbeck system of Bonnot Co. The blast pressure at the burner is higher than in the ordinary type, its value being 2 lbs. at the outlet. The coal consumption to the amount of the furnace charge is as follows:—

	Pulverized coal firing %	Ordinary tuyere coal firing %
Coal for pulverized coal	3.7	—
Lump coal for tuyere coal	0.91	3.63
Coke for charge	0.91	1.56
Total	5.52	5.24

The powdered coal used has a lower heat calorific, being only 84% of that of lump coal. The pulverized coal firing has a tendency to increase the smelting capacity of the furnace. The comparison of the total expense shows that the pulverized coal firing saves about 23 sen per 100 kwan of the charge, under the same conditions.

H. G.

**26. On Influence of Iron upon Alloys consisting of Aluminium and Silicon** (Japanese). **Masaharu GOTÔ** and **Tokushichi MISHIMA**. [Nihon-Kôgyôkwaishi, Ser. XL., 474 (1924), 695-702, with diag., phot. and tables.]—The tensile strength of the alloy increases with the content of silicon, but the presence of iron has no influence on it. The elongation decreases with silicon as well as iron content. When silver is contained, the elongation increases and the tenacity decreases.

H. G.

**27. On Various Aluminium Alloys** (Japanese). **Masaharu GOTÔ** and **Tokushichi MISHIMA**. [Nihon-Kôgyôkwaishi, Ser. XL., 474 (1924), 702-704, with diag.]—According to Bornemann's investigation, it is generally believed that in Al-Ag alloys, Al dissolves Ag but does not form a solid solution. The author observes that Al does combine with Ag and makes a compound  $\text{Ag}_2\text{Al}$ ; when the Al content is from 20% to 31%, the alloy consists of  $\text{Ag}_2\text{Al}$  and eutectic, and when from 31% to 98%, it consists of a solid solution and eutectic. It is also found that the solubility of Ag in Al differs with the temperature, being 40% at 570°C., 11% at 500°C. and 4% at 100°C.

H. G.

**28. On the Physico-chemical Properties and Transformation Points of the Crystalline Structure of Iron and Steel** (Japanese). **Shōnosuke IGUCHI**. [The Suiyō-Kwaishi, IV., 5 (1924), 656-702, with fig. and phot.]—For low-carbon soft steel casting, it is not necessary to raise the annealing temperature much over the point of  $\text{Ac}_3$ . The shrinkage marks on the surface of tensile test pieces show that the annealing temperature is not over  $\text{Ac}$ . The pearite grain is broken by heating between  $\text{Ac}_1$  and  $\text{Ac}_3$ , and the large crystalline of ferrite are formed by heating over  $\text{Ac}_3$ . With high-carbon rolled bars, annealing must be done below the point of  $\text{Ac}_1$  (about 700°C.) as the greater part of the properties due to rolling will be lost by heating over  $\text{Ac}_1$ . It is remarkable that the impact force does not correspond to its impact number. The increase of ferrite grains does not affect the tensile strength, but lowers the shrinkage of its sectional area and its yielding point. The granular cementite occurs in slow cooling after heating at  $\text{Ac}_1$  for a long time.

H. G.

**29. On Graphitization of White Pig Iron, Part I** (Japanese). **Hiroshi SAWAMURA**. [The Suiyô-Kwaishi, IV., 5 (1924), 703-736, with fig. and phot.]—The object of the experiment was to examine the influence of various elements, such as Si, S, Mn, P, Cu, Al, Ni, Co, Cr, V, W, Ti, Mo, Mg etc. on the graphitization of white pig iron. The material was cast in an iron mould, and the tests were performed by dilatometric method, chemical analysis, magnetic analysis and microscopic examination. The author mentions that the exciting reaction of Si for the graphitization of white cast iron depends upon the decomposition of unstable cementite, probably consisting of Fe, C and Si. Further, the author states that the long flaky graphite in grey pig iron will grow in cracks in cementite during the solidifying period of cast iron.

H. G.

**30. On the Dilution of Smelting Smoke** (Japanese). **Chûji YABE**. [The Suiyô-Kwaishi, IV., 6 (1924), 861-875, with diag., fig. and tables.]—The smoke dilution formula for copper ore smelting given by J. Isaachsen was considered. It was discovered that Isaachsen's dilution method was not in some cases practically applicable. The relative motion of smoke and wind is an important factor in dilution speed and, to increase this relative motion, it is necessary to raise the smoke as high as possible in the air.

H. G.

**31. On a Method of Extracting and Refining Metallic Bismuth from the Flue Dust Recovered by the Cottrell Process at the Ashio Copper Mine** (Japanese). **Jûrô SHIMONO**. [The Suiyô-Kwaishi, IV., 6 (1924), 849-860, with fig. and tables.]—The residue of the flue dust from which arsenious acid has been extracted contains many valuable metals such as Bi, Pb, Sn and Zn. To recover them economically the residue was treated in an electric furnace. An alloy consisting of Pb, Sn and Bi settled in the furnace was melted. The liquefaction product was then treated by the dual operation of the simultaneous electrolysis of tin and lead and that of bismuth.

H. G.

**32. On Graphitization of White Pig Iron, Part II** (Japanese). **Hiroshi SAWAMURA**. [The Suiyô-Kwaishi, IV., 6 (1924), 929-971, with fig., phot. and tables.]—In pig iron containing above 4% of Al, two kinds of non-magnetic substances X and Z grow, the maximum growth occurring when the Al content is 9%. When the content is more than 9%, a strong magnetic substance Y appears in it; this increases with the Al content. These substances X, Y and Z do not decompose at high temperatures and are very stable. The amount of graphite growth by graphitization of white pig decreases with the amount of Al, and at above 9% of Al the white pig iron does not graphitize. Up to 10% of Al in white pig, the total amount of carbon shows no change, but when there is more than 10% of Al, the total carbon in it decreases. When the white pig contains 0.8% of Si, the effect of Al on graphitization is more remarkable than when it contains no silicon.

H. G.

**33. An Investigation on Eutectic Crystals** (Japanese). **Matsujirô HAMAZUMI**. [The Suiyô-Kwaishi, IV., 6 (1924), 973-982, with fig. and phot.]—An experiment was made to discover the crystal grain of cell in eutectic alloys. The crystal grain in eutectics can be detected by the etching method only when the metal

in the cell is more basic than the surrounding crystals. The eutectic is nothing but the constituent inlaid within surrounding crystals in polygonal cells. Both these crystals crystallize simultaneously and independently of each other. This action proceeds chiefly by the spontaneous crystallization power of these metals. The primary crystal has a decided effect upon the orientation of the eutectic. H. G.

**34. On the Influence of Small Amount of Metallic Elements upon the Property of Aluminium, the 1st Report** (Japanese). **Takayasu HARADA**. [The Suiyô-Kwaishi, IV., 7 (1924), 1053-1103, with diag. and tables.]—The Al-alloy named 'Halumine' which contains 0.3 to 6% Cu, 0.5 to 6% Ni, and 0.5 to 6% Mn, has the highest resistivity to corrosion. But when this alloy contains zinc, it becomes very corrosive. In a diagram of Al-alloy containing Mn and Fe, specially corrosive points were shown. As to the cause of black corrosion of Al, it is probably due to imperfect removal of caustic soda used for washing, and the removal can be effected most efficiently by a weak chrome medical mixture. H. G.

**35. On Graphitization of White Pig Iron, Part III** (Japanese). **Hiroshi SAWAMURA**. [The Suiyô-Kwaishi, IV., 7 (1924), 1147-1164, with diag., phot. and tables.]—According to the author, phosphorus increases the graphitization of white pig iron, this view differing from that of Wüst and Schössen. Sulphur prevents the graphitization of white pig, and the temperature at which the graphitization in white pig begins is considerably raised by the presence of a small amount of sulphur, its degree being fairly high compared with the result according to Lissner's report. Manganese also prevents graphitization, but does not affect the temperature at which it begins. H. G.

**36. On Sintering Process of Iron Ore** (Japanese). **Kôji YANO**. [Anzan-Tekkôkwaï-Zasshi, I., 10 (1923), 995-1013, with fig. and tables.]—At the Anzan Iron Smelter an experiment with the Greenawalt sintering machine gave unexpectedly good results, and it was found that the concentrate under 0.1 mm. might be briquetted with success. The Anzan sintered ore obtained from this machine has been found to change to magnetic in one case, or hematite in another, differing according to the sintering temperature. The Greenawalt type should be operated at a higher temperature than in the case of the Dwight and Lloyds machine. The sintering process is less expensive than the briquetting, and the sintered ore produced is better than the briquette. H. G.

**37. On the Treatment of Poor Ore at the Anzan Iron Smelter** (Japanese). **Tsunesaburô UMEKE**. [Anzan-Tekkôkwaï-Zasshi, I., 11 (1924), 1093-1140, with fig., phot. and tables.]—The Iron ore of the Anzan Mine contains less than 40% of iron, the main part of the impurity being silica. Reduction roasting is applied to improve the process. The ordinary ore is almost non-magnetic, but by roasting 90% or more of iron can be recovered by Ding's magnetic separator. To obtain the concentrate containing 60% of iron, the ore must be ground to at least 150 meshes, and the recovery of iron is maximum when the ore is ground under 200 meshes. The ratio of the raw material to the reduced ore is 3.5:1.8, while the ratio of the required power is 85:16. This shows that the reduction roasting is profitable. H. G.



38. *On the Reducing Action of Hydrogen, Carbon-Monoxide and Methane upon Hematite* (Japanese). Tsuneo SUZUKI, Masaaki MITA and Saburō ASABA. [Anzan-Tekkōkwaishu-Zasshi, II., 12 (1924), 1-17, with diag., phot. and tables.]—At the Anzan Iron Smelting Works, coke furnace gas is used as a reducing agent for the reduction-roasting of poor ore. H and CO gas act on hematite at 700°C., and reduce it to magnetite, and further to the ferrous state or to free iron. At 700°C. methane rapidly reduces hematite to magnetite. For magnetic concentration, therefore, this gas is an ideal reducing agent without the association of any super-reduction.

H. G.

39. *On Increase of Tensile Strength of Special Steel and Carbon Steel by Cold Drawing* (Japanese). Masayoshi MATSUBARA and Hisashi KUROSE. [Seitetsu-Kenkyūkwaishu-Kiji, 78 (1924), 1-30, with diag., phot. and tables.]—Experiments were made with wire rods of carbon-steel, mangan-steel, chrome-steel, nickel-chrome-steel and high speed steel, and the results are reported.

H. G.

40. *On Steel Casting* (Japanese). Shizuka NOMURA. [Tetsu-to-Hagane, X., 3 (1924), 166-172, with fig.]

41. *On the Relation of the Dimensions and Elongation of Test Pieces, Part II. Forged Steel and Wrought Iron* (Japanese). Keikichi SATAKE and Kajima MUROI. [Tetsu-to-Hagane, X., 4 (1924), 237-251, with diag. and tables.]

42. *On the Forging of Steel Ingots* (Japanese). Shōzō SAITŌ. [Tetsu-to-Hagane, X., 8 (1924), 542-554, with diag., fig. and phot.]

43. *On the Bearing of Iron upon the Economy of Japan* (Japanese). Kaichirō IMAIZUMI. [Tetsu-to-Hagane, X., 9 (1924), 577-599, with tables.]

44. *On Metallic Solid Solutions and Metallic Compounds* (Japanese). Tomojirō TANABE. [Tetsu-to-Hagane, X., 9 (1924), 612-625, with fig.]

45. *On Electrolytic Refining of Copper* (Japanese). Keinosuke HIRAKOSO. [Nihon-Kōgyōkwaishi, Ser. XL., 463 (1924), 188-198, with fig.]

46. *On Heating Variation of Magnesite as Basic Refractory Material* (Japanese). Yoshiaki TADOKORO. [Nihon-Kōgyōkwaishi, Ser. XL., 475 (1924), 767-786, with tables.]

47. *On Peritectic Transformation of Ternary Alloy Systems* (Japanese). Hideo NISHIMURA. [The Suiyō-Kwaishi, IV., 7 (1924), 1139-1146, with diag.]

48. *On the Efficiency of the Hot Blast Stove at the Anzan Iron Smelter* (Japanese). Shin-ichi KOIKE. [Anzan-Tekkōkwaishu-Zasshi, I., 10 (1923), 1014-1023, with tables.]

49. *On a Cause of Defective Steel Casting* (Japanese). Shimpachi UCHIDA. [Seitetsu-Kenkyūkwaï-Kiji, 81 (1924), 119-130, with tables.]

50. *On Steel-Making Operations in the Electric Furnace* (Japanese). Akira ARAKI. [Seitetsu-Kenkyūkwaï-Kiji, 81 (1924), 131-164.]

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## CIVIL ENGINEERING.

Owing to unavoidable circumstances the abstracts of this section were not ready in time for press. They will be published in the next volume.

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## MECHANICAL ENGINEERING (1—49).

**1. Determination of the Best Velocity to be given to Water in the Spiral Casing of a Centrifugal Pump.** Kenjirō ABE. [J. Soc. Mech. Eng. Tokyo, XXVIII., 93 (1925), 37-44, with diag.]—The most favourable velocity in the spiral casing the section of which is circular may be found by the equation  $\lambda B + B\lambda^{\frac{5}{2}} - 1 = 0$ , where  $\lambda$  is the coefficient of casing velocity. This equation can be represented by a diagram which for all practical purposes may be used to determine the best casing velocity with an error of  $\pm 4$  per cent. in the worst case, which can be corrected more accurately, if desired. The proper range of making the throat conical can be determined by the equation  $\lambda \lambda^2 + 0.83B\lambda^{\frac{5}{2}} - 2\lambda + A\lambda^{-1} = 0$ . This is also represented by a diagram, by which the limit of selection of the casing velocity for a certain area ratio of the conical throat can be found. Author.

**2. The Effect of a Spherical Cavity in a Tension Member.** Iwazō NAKAYAMA. [J. Soc. Mech. Eng. Tokyo, XXVIII., 94 (1925), 45-52.]—The effect of a spherical cavity in a tension member is solved by using spherical harmonics of negative degrees. The result shows that the tension in the neighbourhood of the cavity is nearly equal to twice the tension at a distance from it. Author.

**3. The Variation of Error of Registration of Wet and Dry Gas-Meters.** Goichi TSUDA. [J. Soc. Mech. Eng. Tokyo, XXVIII., 94 (1925), 53-71, with fig. and tables.]—The author derived equations of error of registration as functions of rate of flow of gas for meters of each kind. The equations were verified experimentally and proved to be useful for practical purposes. K. K.

**4. The Motion of an Air Bubble rising in Water.** Otogorō MIYAGI. [J. Soc. Mech. Eng. Tokyo, XXVIII., 95 (1925), 97-125, with fig., pl. and tables.]—Air bubbles of various sizes moving upwards in still water are carefully observed experimentally and the motion is treated of theoretically. Their terminal velocities are determined in relation to their sizes, and the changes of their shapes during their motion are investigated.

The mass of water carried up with a moving bubble and the resistance to its motion are determined, and the most probable equation of motion is proposed. It is also proved that there are two different kinds of motion of a bubble in water, exactly analogous to the steam-line and the turbulent flows of a viscous fluid, which passes from the one to the other distinctly at the critical radius of the bubble. Author.

**5. Relation between the Gauge of Railways and the Pressure of Wheels on the Rails** (Japanese). Yasujirō SHIMA. [J. Soc. Mech. Eng. Tokyo, XXVIII., 95 (1925), 129-135, with fig.]—The author discusses the effect of the gauge of railways on unequal distribution of wheel pressure on both sides of a car due to various causes, and concludes that the narrower gauge is unfavorable in this respect. K. K.



**6. Piezo-Electric Indicator for High Speed Internal Combustion Engine.** **Fujio NAKANISHI.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 96 (1925), 153-158, with fig.]—Piezo-electricity of quartz is utilized to measure the rapidly varying pressure in the cylinder. The electric charge due to the pressure is applied to the grid of a valve, and the plate current which varies as the grid voltage is recorded with an oscillograph. By this method indicator diagrams can be taken with sufficient sensitivity and accuracy even at the speed of 5,000 r. p. m. or more. Another merit is that the record can be taken at any distance from the engine. Author.

**7. Stresses due to Shrinkage of One Hollow Cylinder on Another.** **Iwazō NAKAYAMA.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 96 (1925), 159-168, with tables.]—The equations to calculate stresses and displacements of single or compound cylinders under uniform pressure are deduced from the stress function  $F$  which satisfies  $\nabla^2 F = 0$ . The axial displacements or axial stresses are easily calculated from the equations. Next the effects of the force in the axial direction at the junction of compound cylinders due to cooling contraction are considered by using Bessel's function which satisfies  $\nabla^2 F = 0$ , and numerical examples are offered. Author.

**8. A Study of Pipe Lagging.** **Kazuo KUMABE and Wataru NAGANO.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 97 (1925), 229-290, with fig. and tables.]—The first half of the paper consists of a theoretical study of the effect of various parameter of pipe lagging, viz. emissivity of surface, thermal conductivity of material and the thickness of lagging upon the insulating ability of heat. The second half is a description of the experiments made by the authors. The thermal conductivity of various home lagging material was observed by an electric method, and the result summarized as a simple function of the specific density of the material.

The effect of the thickness which was studied in the first half was confirmed experimentally also. Authors.

**9. On the Distribution of Shearing Stresses in Beams of Certain Cross-Sections.** **Tuneo INOKUTY.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 97 (1925), 291-322, with fig.]—The distribution of shearing stresses in a beam is mathematically investigated for two forms of cross-sections, namely, (1) a section bounded by two confocal ellipses, and (2) a sector of a circle. From Saint-Venant's flexure functions the shearing stress components are obtained. It is pointed out that, at a sharp corner projecting outwards in the cross-section of a beam, the shearing stress is zero, and, at the end of a crack and near the corner of a sharp re-entrant in the cross-section, the shearing stresses become very great. But, if the sharp corner is on the vertical symmetrical axis of the section, the shearing stress at the corner of such a re-entrant is zero, and, if the crack is along the vertical symmetrical axis, the distribution of the shearing stresses on the section is not influenced by the presence of such a crack. Some further remarks for a thin hollow elliptic cylindrical beam, circular cylindrical beam, and circular hollow cylindrical beam are given. K. K.

**10. On the Thermal Efficiency of High Speed Diesel Engines (Japanese).** **Toyōji NARITA.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 97 (1925), 323-333, with fig.]—The shape of most indicator diagrams taken from high speed Diesel engines is quite

different from that of the Diesel cycle; i.e., in the latter the fuel burns at constant pressure at one time, while in the former the combustion takes place in two phases. A part of the fuel burns first at nearly constant volume at the end of compression, next the remaining part of it burns at nearly constant pressure at the pressure attained by the former combustion, thus approximating the so-called Sabathe cycle. It is attempted in this paper, first to deduce the formulae for the thermal efficiency of the said cycle, and next to compare the thermal efficiency of the said cycle with that of the Diesel cycle.

Author.

**11. *Endurance Test of a Beam with a Sudden Change in Cross-Section*** (Japanese). **Bunzaburō KURAISHI**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 97 (1925), 334-340, with fig.]-The endurance test of a steel cantilever beam with a sudden change in cross-section is performed by exciting its free vibration of the first or second order by an A. C. electromagnet. It is found that the fatigue occurs very rapidly when the ratio of two portions of the beam approaches to a definite value, and the fracture occurs always at the point of the discontinuity of the section.

Author.

**12. *On the Locomotive Feed Water Heater*** (Japanese). **Rokurō SUMIYAMA**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 98 (1925), 365-370, with fig.]-It is pointed out that, as steam is used only intermittently in a running locomotive, the ordinary arrangement of feed heating in which the function of heating is only possible when the throttle valve is opened cannot be said to be fully efficient. The author proposes a new design which is provided with auxiliary hot water tanks. Hot feed water is supplied from the auxiliary tanks when the locomotive is coasting, thus the supply of hot feed water is made always possible.

K. K.

**13. *On Heat Transmission through Condenser Tube Wall*** (Japanese). **Kankurō KANESHIGE**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 98 (1925), 371-385, with fig. and tables.]-The heat carried off by fluid from a surface, apart from the effect of radiation, is proportional to the internal diffusion of the fluid at and near the surface. The rate of this diffusion depends first on the nature of the fluid and secondly on the effect of eddies which arise entirely from the motion of the fluid, and is proportional both to the density of the fluid and the velocity with which it flows past the surface. The author investigated the heat transmission between water through the condenser tube wall and verified Reynolds' law of heat transmission. It was also shown that the twisted retarder inserted in the cooling water passage substantially improved the transmission of heat. Moreover a phenomenon which was supposed to be the effect of the critical velocity was observed in the experiment.

Author.

**14. *Relation between the Physical Properties of Steel and its Forging Directions*** (Japanese). **Shōzō SAITŌ**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 98 (1925), 386-395, with fig. and tables.]-In forging shops the ingot or bloom is sometimes forged either by first stamping sideways and then upsetting or by this procedure in reverse order. The object of this investigation is to find out some of the effects caused by the above mentioned processes upon the properties of the material, comparing

them with the known fact that the ordinary forging produces good effects in the longitudinal test but injurious ones in the transverse test.

In the present experiment the material was subjected to the lengthening and upsetting operations and the author found that the result of the material tests indicated the existence of the combined effect of the good and bad influences of the operations.

The author found also that the last forging was more effective than the preceding ones and that it chiefly determined the final mechanical properties of the material.

Author.

**15. *Experiments on Guide Vanes and Divergent Vortex Chamber without Guide Vanes for a High Pressure Centrifugal Pump*** (Japanese).

**Tokusaku ŌMORI.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 98 (1925), 397-428, with fig. and tables.]—The efficiency of the centrifugal pump depends very largely on the efficiency of converting the kinetic energy of the water leaving the impeller into the form of pressure. There are two methods of energy-conversion generally adopted by designers of centrifugal pumps: one is to use the vortex or whirlpool chamber and the other the guide vane. Modern pump design appears to be tending to use the vortex chamber for low and medium types and the guide vane for the high pressure type.

The object of the experiments is to study whether any variation in the efficiency and other characteristics of a high pressure centrifugal pump occurs, when fitted with guide vanes of different vane angle at entrance and divergent vortex chamber without guide vanes. The comparison between the guide vanes and the vortex chamber is perhaps best seen from the attached figures. It would be generally stated that even for a high pressure centrifugal pump as good efficiency is obtainable from a vortex chamber pump as from a guide vane pump provided that a correct design of the vortex chamber is made, and also, that since the efficiency of the pump fitted with a guide vane depends largely on the suitability of the vane angle, great care should be taken in the determination of the vane angle.

Author.

**16. *Lateral Vibrations of Tapered Bars*.** **Akimasa ONO.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 99 (1925), 430-441, with figs. and tables.]—The lateral vibration

of a clamped-free bar is made the subject of investigation in continuation of the author's article on vibrations of turbine blades, by taking the cross section and the moment of inertia to vary in a linear relation with the distance from a certain origin, and assuming the radius of gyration to be constant as in the previous note. First Rayleigh's method of an assumed type has been applied to find the frequency of the gravest mode of vibration, and then the smallest characteristic constant of an integral equation has been approximately calculated for the same end. The former method gives, as is well known, an upper limit to the frequency, while it is shown that a lower limit may be found by the latter method. On comparing these results with the root found by solving the boundary problem in the usual way, the lower limit is in rather good agreement with the true, the error being 1.5% in the uniform bar, and 3.2% in the bar with a pointed tip. Lastly, the lateral vibration of a flexible bar in rotation has been considered by Rayleigh's method. The result may be combined with the frequency of the elastic bar in rest by Lamb-Southwell's method to find the approximate value of the frequency in rotation.

Author.

**17. Experiments on a Pelton Wheel with Special Reference to Various Buckets** (Japanese). **Kazu SHŌGENJI**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 99 (1925), 442-470, with fig. and tables.]—Buckets of various forms are tested on a Pelton wheels, showing the efficiency of each. The efficiency of a wheel being defined by the product of the nozzle, the volumetric, the mechanical, and the hydraulic efficiency of a bucket, each efficiency is measured or calculated separately. The hydraulic loss of buckets or the so-called wheel loss is the sum of bucket loss and discharge loss, both of which are separately calculated, and it is shown that the former decreases with increasing speed of rotation of the wheel, while the latter becomes minimum for a certain speed. The hydraulic efficiency of buckets is maximum for a certain ratio of the bucket and jet areas, and is the largest maximum in the neighbourhood of the speed for which the discharge loss is minimum. Author.

**18. Design of Pelton Wheel by means of Specific Speed** (Japanese). **Ken-ichi MINAMIŌJI** and **Yoshio YOKOYAMA**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 100 (1925), 471-488, with fig. and tables.]—Some practical notes on the design of the pelton wheel using a specific speed  $n_s$  are given in the paper. Expressing wheel ratio, number of buckets and ridge inclination as functions of  $n_s$ , the standard jet diagram to determine the chief dimensions of the wheel is drawn. K. K.

**19. The Patent Lead Powdering Process and the Application of the Products and their Effectiveness** (Japanese). **Genzō SHIMAZU**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 100 (1925), 489-516, with fig. and tables.]—In this paper the author intends to illustrate how this remarkable invention relating the lead powdering process has been developed to the present successful stage, while showing the details of this new process and also the applications of the products—Lead Powder, Litharge and Red Lead—and their effectiveness. Author.

**20. Buckling of a Long Helical Spring under the Compressive Load.** **Eiji UTSUMI**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 101 (1925), 602-608, with fig.]—A spring under compressive load is liable to be in an unstable state. A formula of this phenomenon is deduced in this paper, treating the spring as a rod with equivalent moment of inertia against bending moment; then the relations between length, load and stiffness are found by Euler's theory of long columns. The equivalent moment of inertia is approximately the multiplication of the moment of inertia of the spring wire into  $\frac{\sin \alpha}{1.125}$ , where  $\alpha$  is the helical angle of the spring in the loaded condition. Author.

**21. Stresses of a Ring.** **Morinao NAKAZAWA**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 101 (1925), 627-636, with fig.]—The ring discussed in the paper is of large diameter compared to its cross section. An analysis of the stresses is treated by the method of least work, not being the theory of curved beams, neglecting the tangential and direct normal strain. An example represented in a somewhat general form being solved, the cases from its combination and special cases are illustrated. Author.



**22. On the Strength of Spiral Casing of Water Turbine** (Japanese). **Ken-ichi MINAMIÖJI**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 101 (1925), 637-674, with fig.]-The Spiral Casing is one of the heaviest pieces among the machine elements that constitute the Francis Turbine and it is also subjected to heavy stresses due to hydraulic pressure, sometimes accompanied with severe hammering actions. Owing to the complexity of the form, it is not easy to make beforehand an exact calculation on this subject, but the author thinks it would be of some use even if we could get a rough estimation of values as to the internal stresses under possible working conditions, and he has therefore endeavoured to find the approximate solution of this question.

In the paper the problem is discussed as an applied case of the formulae of the strength of curved beams and the author introduces a few cases of actual plants in this country as numerical examples. Author.

**23. On a New Cycle of Internal Combustion Engine** (Japanese). **Masaaki HANADA**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 101 (1925), 676-716, with fig. and tables.]-Actual internal combustion engine indicator diagrams are always different from those of theoretical cycles such as the Diesel or Otto cycles.

The author attributes this fact to the difference of the state of heat supply in cycles and actual combustion (or explosion) of engines, and proposes a new cycle in order to make this clear, in which he treats the heat supply as a function of time.

He deduces the relation between volume, pressure, and heat supply in a perfect gas as follows:—

$$Vdp + \gamma p dV = \frac{mR}{K_n} q dt$$

Solving and applying this to a state of medium in a working cylinder, he gets the general formulae of the new cycle.

By substituting several practical reasonable values of volume and supply in the general formulae he gets the following practical modified forms:—

Case 1. Constant pressure cycle:—which suggests the ideal condition of heat supply for Diesel engines.

Case 2. Constant heat supply cycle:—which nearly coincides with actual Diesel engine indicator diagrams.

Case 3. New gas engine cycle:—which nearly coincides with actual gas engine indicator diagrams.

In a later part of this essay he describes several numerical examples for Cases 2 and 3.

From these investigations he finds that the cooling loss can be reduced considerably by using suitable construction of combustion space with respect to form, wall insulation and etc.

Further investigations are left for the future, but the new cycle, he says, will be useful for analysing actual indicator diagrams, and for improving actual engine performances. Author.

**24. Semi-Graphic Solution of Beams** (Japanese). **Morino NAKAZAWA**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 101 (1925), 765-796, with fig.]-In order to make the analysis of beams less laborious, the author derives four fundamental and five auxiliary formulas, proved by means of the semi-graphic method. Six standard examples

are fully explained by these formulas, not using higher mathematics. Four examples represented in a somewhat more general form are solved, being considered as combinations or special cases of the standard examples. The examples of the continuous beam are explained lastly. The one hundred and twenty-two formulas obtained from these examples may be applicable with less labour to numerous problems arising in practice.

Author.

**25. *A New Repeated Torsion Tester* (Japanese). Bunzaburō KURAISHI.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 102 (1925), 797-817, with fig. and pl.]—In a high speed repeated torsion tester of constant stress range type designed by the author, the test piece is to be clucked one end on the armature of an oscillating motor and the other end to the torsion bar. The torsion bar is used to measure repeated torque by the method of lamp and scale. The construction of the oscillating motor is the same as on ordinary D.C. motor, and if alternating current or pulsating current of any frequency is supplied to the armature while direct current is being supplied to the field coils, the armature will exert alternating or pulsating torque on the test piece.

The so-called rapid method proposed by Gough can also be carried out simply and accurately by this machine. (But the author could not find any such a fatigue limit as found by Gough).

In carrying out the endurance test, it is advisable to use the resonance phenomena of torsional vibration, because in the vicinity of that frequency the armature current decreases and the wave form of repeated torque becomes more regular.

Adding some simple attachments to this machine, ordinary simple torsion tests can also be carried out.

The test pieces to suit this machine can be made simply and accurately by means of a milling machine giving rotation and axial feed to the test pieces. Author.

**26. *On the Water Power in Our Country* (Japanese). Hidesaburō NAKAYAMA.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 102 (1925), 836-854, with fig.]—This is an account of a statistical and topographical survey of water power in Japan.

K. K.

**27. *Hardness and Hardness Measurement*. Senji KOKADO.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 103 (1925), 857-903, with fig. and tables.]—The following two fundamental proposals as to the definition and the scale of hardness are given:

1. The hardness of a material is its ability of unyieldingness by compression.
2. Let the stress ( $\sigma$ ) strain ( $\epsilon$ ) relation of a material by simple compression be

$$\epsilon = f(\sigma), \text{ then the hardness number is } H = \int_0^1 \sigma d\epsilon.$$

To find this new hardness scale from the results obtained by the Brinell and the drop ball hardness tests, several formulae, which represent the relations between the applied load or energy and the amount of indentation, are deduced from several probable assumptions; then the proposed new hardness scale is calculated from these results.

Incidentally many phenomena which have been already discovered from experiments are proved mathematically. Author.

**28. *A Contribution to the Photo-Elasticity* (Japanese). Kan-ichi YAMAGUTY.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 103 (1925), 906-916, with fig.]—The author investigated the stress distribution in the thin round disc with holes of various proportions at the centre when compressed with two parallel planes. He concluded that the result of the experiment agreed very well with the theoretical calculation by Prof. Föppl, and retained some doubts on the truth of the usual theory of curved beams for such cases.  
K. K.

**29. *On Engineering Standardization Work* (Japanese). Shōji KONISHI.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 103 (1925), 917-936.]—This is a report of the history and present state of engineering standardization work in Japan.  
K. K.

**30. *On Tooth Profiles with reference to the Path of Contact*. Masao NARUSÉ.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 104 (1925), 939-952, with fig.]—In this paper the form of a tooth profile, of which the path of contact is a conic curve, is studied mathematically, and various forms of profile are derived as its special cases.

First, the profile in an elliptic path of contact is obtained, and as its special cases, the profiles in hyperbolic, parabolic, circular and straight paths of contact are derived.

Next, the inverse curve of a conic section with respect to a focus, or the limaçon, is taken as a path of contact, and some profiles, a circle, a straight line etc., are derived by changing the form of the limaçon.  
Author.

**31. *On the Temperature and Stress Distributions in the Wall of a Long Hollow Cylinder Subjected to a Periodic Flow of Heat*. Michijirō MAEKAWA.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 104 (1925), 953-975, with fig.]—Using the Fourier conduction equation the temperature distribution in the wall of a long hollow cylinder is derived, both sides of the cylinder being considered as filled with fluid of different temperatures, that of the inner (outer) fluid varying periodically while that of the outer (inner) fluid remains unchanged. The calculation is conducted by the aid of the Ber and Bei functions and the solution is expressed in a comparatively simple form so that its physical meanings can easily be understood.

The obtained temperature distribution is applied to the formulae of the thermal stress to find its state in this case. Consequently it is pointed out that the stress is the most severe at the surface in contact with the fluid of varying temperature.  
Author.

**32. *A Further Study on Pipe Lagging*. Kazuo KUMABE.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 104 (1925), 976-997, with fig. and tables.]—A supplement to the author's previous paper on the same subject. The subject is extended to more general cases, i.e. for heating and cooling periods. The chief object of the investigations is to find the law governing the loss of heat in such cases, and fundamental equations under suitable boundary conditions are solved. The conclusion is, as far as the pipe lagging is concerned, that practically always the ordinary equation of loss of heat in an equilibrium state of heat will serve for the calculation of loss of heat. In the paper the value of temperature to be inserted in the formula is discussed for several cases, and the error due to simplified calculations is also investigated.  
Author.

**33. On a New Balancing Machine** (Japanese). **Kyōji SUYEHIRO** and **Isoo KUNO**. [J. Jap. Soc. N. A., **36** (1925), 17-22, with pl.]—This is a full account of the mechanical details and the actual performance of a balancing machine devised by the authors. The principle of the construction of the machine was previously reported to the J. Soc. Mech. Eng., and an abstract of the report given in Vol. II pp. 10 of this Journal.

According to the present report, with this machine it takes 4 days for a perfect balancing of rotors weighing say 2 tons, the lower limit of detectable unbalancing being nearly 0.1 lb-in or so for such rotors. Authors.

**34. Distribution of Elongation over the Gauge Length of Tensile Test Bar and Some Notes on the Measurement of Ductility of Structural Steel by Tensile Breaking Test.** **Kazuma MINATO**. [J. Jap. Soc. N. A., **36** (1925), 23-72, with fig. and tables.]—The Author obtained the distribution of elongation and reduction of sectional area over the gauge length of many mild steel test bars subjected to tensile breaking, analyzed the ultimate elongation into general uniform elongation and local extra elongation, and tried to find some relations between total elongation, general uniform elongation, local extra elongation, reduction of sectional area at the point of rupture and ultimate tensile strength.

The important points ascertained by the investigation are: (1) The ultimate elongation over a certain gauge length is the sum of an arbitrary proportion of local extra elongation and general uniform elongation according to the quality of the material, there being no definite proportion except in test bars cut from an ideal material of a certain quality in which M. Barba's law of proportionality holds good. (2) Therefore, in ordinary cases such as in testing batches of steel ship plates, where M. Barba's law does not hold good, the comparison of amounts of ultimate elongation of test bars at a certain gauge length differs from the comparison of those at another gauge length. (3) Consequently the comparison of ultimate elongation at a certain gauge length does not mean the comparison of ductility of the materials compared.

He also discusses about several existing methods of measuring ductility by tensile breaking tests, and the conclusions may be summarized as follows: (1) The accuracy of the method of measuring ductility by the ultimate elongation depends entirely upon the hypothesis that there is a certain fixed relation between general uniform elongation and local extra elongation. But this hypothesis is not correct in case of actually testing materials. (2) The ductility essential for the materials of construction, especially in tension members, is the general uniform elongation, i.e., the plastic deformation at the moment of the maximum load just before the local drawing begins. After the local drawing begins, the material breaks down very quickly, and consequently it is unreasonable to rely upon the ductility beyond that of the maximum load. (3) Therefore, it is preferable to disregard the elongation beyond the moment of the maximum load.

Finally the author proposes one method of measuring the most probable general uniform elongation of a test bar subjected to the tensile breaking test. The method is claimed to be very simple and practicable and much quicker and less troublesome than that of Prof. Unwin's. Author.

**35. Elastic Stability of a Thin Circular Ring and of an Infinitely Long Thin Circular Cylindrical Shell under Radial External Pressure.**



**Takesada TOKUGAWA.** ["Zassan," Jap. Soc. N. A., **45** (1925), 1-14, with fig.]—Problems of the elastic stability of a circular ring and a cylindrical shell subjected to external pressure have an important application in the design of structural members of a submarine hull. The author states several fundamental methods of dealing with elastic stability, i. e.

- (1) Statical method,
- (2) Vibration method,
- (3) Energy method,

and shows their application to the determination of the collapsing pressure of circular rings. Author.

**36. On a Method of Direct Measurement of Poisson's Ratio** (Japanese). **Zirō TSUZI.** [Bull. Inst. Phy. Chem. Research, Tôkyô, IV., **1** (1925), 39-43, with fig.]—A metal test piece with uniform rectangular section is stretched by a horizontal testing machine. The displacement of the upper surface in reference to the lower surface is observed by interference fringes of sodium light produced by two glass plates, one of which is placed on the upper surface and the other connected to the bottom surface. Mild steel, copper and brass are tried; they prove considerable accuracy for this method. Author.

**37. Piezo-electric Indicator for High Speed Internal Combustion Engine** (Japanese). **Masatoshi ÔKÔCHI, Shitiryo HASHIMOTO and Shinsaku MATSUI.** [Bull. Inst. Phy. Chem. Research, Tôkyô, IV., **1** (1925), 85-97, with fig.]—The pressure variation in the cylinder of a high speed internal combustion engine is photographically recorded by a string electro-scope. The string is charged by the piezo-electricity of quartz just corresponding to the pressure in the cylinder.

The temperature effect of the quartz on the piezo-electricity is measured, and it is observed that the pressure is lower, between 3°C. and 17°C., by 0.001 kg/cm<sup>2</sup> per degree of temperature rise, while no temperature effect is visible in the range between 17°C. and 74°C.

The engine used in the experiment is a horizontal 4 cycle gasoline engine for a motor-bicycle.

The pressure photographs taken at various speeds from 1,050 R. P. M. to 3,050 R. P. M. are shown in six record sheets, and the explanations are given for the exact state of pressure inside the cylinder in relation to the time and the position of the piston. The conclusion obtained is that the pressure variation in the cylinder of the high speed engine can photographically be recorded by the Piezo-electric Indicator with no significant error due to the inertia of the string of the electrometer. Authors.

**38. The Effect of Lower Temperatures on the Modulus of Elasticity of Carbon Steel** (Japanese). **Zirō TSUZI.** [Bull. Inst. Phy. Chem. Research, Tôkyô, IV., **3** (1925), 336-342, with fig.]—Young's Modulus of carbon steel of 0.1 to 1.5% C is determined over the range of -180° to 0°C. by means of bending. A rectangular beam, both ends supported and loaded at the centre, is cooled to -183°C. in a brass vessel with the liquid air. The deflection is transmitted by fused quartz rods out of the vessel and measured by optical levers, and slowly from -180°C. to 0°C.

Young's Modulus seems to increase by 6~20% in the range from 0°C. down to -100°C., the lower the carbon content the greater being the increase. Under -100°C. the increase becomes far more rapid. Author.

**39. Investigation of the Methods of Mechanical Tests** (Japanese). Kōtarō HONDA. [Bull. Inst. Phy. Chem. Research, Tōkyō, IV., 6 (1925), 726-735, with fig.]—A preliminary note on the various modes of mechanical failure of material. The following are the author's chief conclusions:—

(1) The breaking energy absorbed by a test piece in practical methods of testing may be analysed into the following three kinds, i.e. the energy necessary merely to break down without plastic deformation; the energy of deformation; and the kinetic energy directly after the breaking. The second is the predominating one.

(2) The breaking energy is the same for statical and dynamical tests provided that a test piece deforms in a similar way for both cases.

(3) The result of the impulsive bending test by a notched test piece has only a comparative meaning. The energy absorbed is proportional to the angle of deflection.

(4) In the repetitive impulse test, the fatigue of material proceeds slowly at first, then at an increased rate. The degree of fatigue produced in the course of an experiment may be judged by measuring the breaking energy by impulse or bending. The said degree of fatigue can also be deduced indirectly by some physical properties such as electric resistance or magnetic property. K. K.

**40. A Note on the Power Consumption of a Piston Compressor and a Vacuum Pump.** Michijirō MAEKAWA. [Technology Report of the Tōhoku Imp. Univ., Sendai, V., 4 (1925), 25-42, with fig. and pl.]—The author points out that a higher mean effective pressure than a working one will be met when a piston compressor is started, if the compression ratio is larger than a certain value which he calls the critical compression ratio.

The same thing holds good for the piston vacuum pump. The author deduces practical formulas to calculate the said pressures and he claims that the power of the driving motors of these pumps should be determined on the basis of these considerations. K. K.

**41. Partial Discussion on Impulse and Reaction Turbines** (Japanese). Kōtarō YOSHIDA. [J. Soc. Mech. Eng. Tokyo, XXVIII., 93 (1925), 1-36, with fig.]

**42. On an Experiment with Water Rams** (Japanese). Sukeshige TAGA. [J. Soc. Mech. Eng. Tokyo, XXVIII., 97 (1925), 341-354, with fig.]

**43. An Example of the Solution of Generalized Plane Stress.** Takesada TOKUGAWA. ["Zassan," Jap. Soc. N. A., 43 (1925), 7-27, with fig.]

**44. A History of the Problems of Elastic Stability** (Japanese). Takesada TOKUGAWA. ["Zassan," Jap. Soc. N. A., 44 (1925), 1-12.]

**45. Test Result of Saturated and Superheated Steam Locomotives, Fourth Report** (Japanese). Kenjiro KUWABARA. [Bull. Imp. Gov. Rwy. Research Office, XIII., 3 (1925), 223-230, with tables.]

**46. *Relation between Evaporation and Rate of Combustion in Steam Locomotives*** (Japanese). **Kenjirō KUWABARA**. [Bull. Imp. Gov. Rwy. Research Office, XIII, 3 (1925), 231-246, with fig. and tables.]

**47. *Calibration of Accelerometers*** (Japanese). **Kuraji MUSASHI**. [Bull. Imp. Gov. Rwy. Research Office, XIII, 4 (1925), 405-417, with fig.]

**48. *Investigation of Springs*** (Japanese). **Masaji IKEDA**. [Bull. Imp. Gov. Rwy. Research Office, XIII, 6 (1925), 531-557, with fig. and tables.]

**49. *Relation between Air Pressure, Capacity of Auxiliary Tank, Stroke of Brake Piston etc. in Pneumatic Brakes*** (Japanese). **Shin-ichirō HAMANO**. [Bull. Imp. Gov. Rwy. Research Office, XIII, 8 (1925), 743-755, with fig.]

## NAVAL ARCHITECTURE (1—8).

### 1. *Notes on Resistance to Flow of Viscous Fluids.* Kyōji SUEHIRO.

[J. Jap. Soc. N. A., **36** (1925), 87-91, with fig.]—According to the author's view, even when the flow of a viscous fluid becomes turbulent, a thin layer just close to the boundary walls persists in making a stable laminar flow. The thickness of this stable layer is likely to be self-adjusting to conform with the condition for the stability of uniform shearing motion; the larger the mean speed of the eddy flow, the thinner will be the thickness of the layer. From Orr's and Reynolds' numbers for the critical speed of flow between parallel walls the author has calculated the probable thickness of the stable layer, and therefrom the resistance to flow of a viscous fluid in a pipe.

To confirm his view the author carried out an experiment after Reynolds' method, with the slight modifications that in his case a glass pipe was placed vertically and two coloured filaments were let into the pipe, one at the centre and the other close to the wall. He confirmed that even when the turbulence started in the central part, the flow just close to the wall retained its stability.

Author.

### 2. *Results of the Actual Trial of the "Matora's Shipstabilizer"*

(Japanese). Shintarō MOTORA. [J. Jap. Soc. N. A., **36** (1925), 105-113, with pl.]—A "Matora's Shipstabilizer" was installed, for the first time, on board S.S. Mutsu Maru, a passenger boat of the following dimensions, etc.:  $L \times B \times D$ , 160'-0"  $\times$  27'-0"  $\times$  15'-6", 520 tons gross, and speed 12 knots. Her service is to ply between Hakata and Izuhara via Iki. The fins of the stabilizer were fitted one on each side of the ship at the bilge, forward of the boiler room bulkhead. Their dimensions are: length 3'-5" and breadth 3'-2". The fins are operated by a vertical steam steering engine which is controlled by a small gyroscope, the precession of the latter due to the rolling of the ship being utilized to control the electric circuits connected to the differential valve of the steering engine.

Results of the first trial (April 20th, 1923): The sea was too calm to test the stabilizer among waves; so that the maximum attainable amplitude of the rolling forced with the fins, and also the quenching power against the rolling, were observed, showing a fair coincidence with the model experiment.

Results of the second trial (Nov. 17th, 1923): The sea condition was favourable. It was observed that when the stabilizer was in action, the average amplitude of rolling was 3° and the largest amplitude was 15°, while when it was out of action they were 12° and 27° respectively.

Thus the result was very satisfactory. The comparison of the sea trials with the model experiments is also reported.

Author.

### 3. *Precaution to be taken against Earthquake in laying a Ship's Hull on the Building Berth* (Japanese). Masatsune YAGASAKI. [J. Jap. Soc.

N. A., **37** (1925), 5-14, with fig.]—The author gives a full account of his personal observations of the damage sustained by a ship's hull on the berth and her supporting arrangements such as keel blocks, bilge blocks, shores, etc., in the dockyards situated in



the devastated area of the great Kwanto earthquake in 1923. He points out which part is liable to be wrecked by an earthquake and suggests means to avoid such damage.  
T. M.

**4. Axial Thrust and Bending Moment of a Horizontal Circular Cylindrical Ship with her Deck just immersed in Water.** Takesada TOKUGAWA. ["Zassan," Jap. Soc. N. A., 44 (1925), 1-13, with fig. and tables.]—The author considers firstly the following simple cases and afterwards combines them:—

- (1) a cylinder subjected to outer hydro-static pressure,
- (2) a cylinder subjected to symmetrical radial forces,
- (3) a cylinder subjected to symmetrical bending couples.

Since the force on the structure is determinate in each case, the author deduces analytically the expressions for the thrust along the periphery and the bending moment at any point of the cylinder.  
T. M.

**5. The Effect of the Horizontal Flange of a Rudder on the Turning of Ships** (Japanese). Tomoyoshi HAGI. ["Zassan," Jap. Soc. N. A., 46 (1925), 1-4, with fig.]—The author holds the view that good turning quality can be obtained by fitting a flange on the horizontal edges of a rudder. To confirm the view he made experiments with a model in a small tank, and obtained the following results:—

- (a) When a flanged rudder is fitted to a model, the radius of the turning circle becomes smaller than that of the model fitted with an ordinary rudder;
  - (b) The wider the flanges are, the better is the turning quality;
  - (c) Roughly speaking, a rudder having two or three flanges seems to be superior to that having one.
- T. M.

**6. On Refrigerated Ships and their Equipments** (Japanese). Fujimaru TSUCHIYA and Mitsuo KUJIME. [J. Jap. Soc. N. A., 36 (1925), 73-82, with fig. and pl.]

**7. On Fitting Out Submarine Boats** (Japanese). Ritsunosuke HOZUMI. [J. Jap. Soc. N. A., 36 (1925), 93-104, with pl.]

**8. On the Contra Propeller fitted to the "Tsuruha Maru"** (Japanese). Keizō NAKANE. ["Zassan," Jap. Soc. N. A., 43 (1925), 1-6, with fig.]

## AERONAUTICS (I—16).

1. *The Inertia Forces and Couples and their Balancing of the Star Type Engine.* **Keikichi TANAKA.** [Rep. Aeronaut. Research Inst. Tōkyō Imp. Univ., I, 10 (1925), 247-302, with fig.]—Usually the dynamics of the star type engines are approximately treated assuming that they have single obliquity. In other words, all their connecting rods are directly attached to one common crank pin. The object of the present paper is to study the inertia forces and couples and their balancing of these engines, taking the double obliquity into account. This investigation consists of three parts; Part I, the radial engine; Part II, the rotary engine; and Part III, comparisons with other types of engines. Author.

2. *On the Valve Method of Measuring Small Motion, with Special Reference to the Precise Recording of Sounds, Pressure-Variations and Vibrations.* **Jūichi OBATA and Yahei YOSHIDA.** [Rep. Aeronaut. Research Inst. Tōkyō Imp. Univ., I, 11 (1925), 305-319, with fig.]—The paper contains the results of a series of experiments which were carried out with a view to apply the methods of measuring very small motion, utilizing a generating circuit containing a triode, to the precise recording of sounds, pressure-variations and vibrations.

A tuned grid circuit was employed and a small transformer was inserted in the plate circuit instead of balancing the plate current by means of the potentiometer method, an Einthoven string galvanometer or a high frequency oscillograph being used as the recording instrument.

To record sounds a condenser microphone was employed as the capacity in the generating circuit, and records of the sound of explosion, vowels and whistle were obtained. The microphone was slightly modified to record pressure-variations.

Finally, on the basis of the authors' experiments, a special instrument called an "Ultramicrometer" has been constructed, which may be conveniently used for the same purposes and other problems requiring the measurement of very small displacement or motion. With this instrument the capacity method as well as the eddy current method may be carried out, the circuit being in all cases the "tuned grid." The plate current may be balanced or a transformer may be inserted according to the kind of problem. Authors.

3. *The Standard Atmosphere and the Corrections to be applied to a Reading of an Altimeter* (Japanese). **Takurō TAMARU.** [Rep. Aeronaut. Research Inst. Tōkyō Imp. Univ., I, 12 (1925), 321-346, with tables.]—The author deduces numerical relations of height, pressure and density of atmospheric air, based on suitable assumptions with regard to the standard condition. Formulae for corrections to be applied, when the actual value of temperature,  $g$ , and density of air are known, to a reading of an altimeter graduated according to the standard atmosphere are worked out. The method of calculation is shown in an example. K. K.

4. *A Method of Balancing S-Cyl. 90°-V Engine.* **Fujio NAKANISHI.** [J. Soc. Mech. Eng. Tokyo, XXVIII, 96 (1925), 169-176, with fig.]—The author shows

that by using an unsymmetrical crankshaft and attaching suitable balance masses, the second harmonic of the inertia force due to the reciprocating mass of an 8-cyl. 90°-V Engine can be eliminated.

K. K.

**5. Ueber die Verbesserung der Stroemung in Windkanalen. C. Wieselsberger.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 98 (1925), 357-364, with fig.]-The most important aerodynamical qualities that should be aimed at in wind-tunnel design are as follows: (1) Constant and parallel direction of flow; (2) Uniform velocity across all sections; (3) Absence of turbulent motion; (4) Constant velocity of flow.

The Göttingen type of wind-tunnel with a parallel part before the working section, of which the section is steadily reduced, realises in a high degree all the above mentioned qualities. It is shown that this system can easily be applied to other wind tunnels, for instance the N. P. L. or Eiffel types. An Eiffel tunnel of 1.25 m. diameter, which was ultimately constructed with a design based on this principle, gave very satisfactory results.

Author.

**6. Effect of Altitudes on the Power of Aero-Engines. Akira KOBAYASHI.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 101 (1925), 551-601, with fig. and tables.]-The decrease in the power output of aero-engines due to altitude has been already computed by several authorities. Most of them proceeded with the law of Welter that the quantity of heat liberated by the combustion of gasoline sucked into an engine cylinder is proportional to the weight of oxygen carried in with the gasoline. In this paper the same problem is treated, a little more theoretically from the thermodynamical point of view, though the final result is not much different. Firstly, the formula for the mean effective pressure is deduced in terms of the pressure  $P$  and absolute temperature  $T$  of the fresh charge, the compression ratio  $\rho$ , the ratio  $\gamma$  of specific heats of the working fluid, and the temperature rise  $\Delta T$  due to the internal combustion. The first two factors  $P$  and  $T$  depend directly upon the conditions of the surrounding atmospheric air and the other two  $\gamma$  and  $\Delta T$  upon the chemical composition of gasoline and the ratio of air to gasoline in the fuel mixture as well as the ratio of compression. All these factors are computed theoretically, and the results are applicable not only to gasoline engines but also to other internal combustion engines.

The retention of the horse power of aero-engines at high altitudes can be effected by two different systems, namely, by supercharging, or by increasing the compression ratio. The author's formulae may be used for the calculation of the latter system, which is of more interest in commercial service as it has an advantage for increasing fuel economy rather than power output. The author's own device for increasing the compression-expansion ratio is also described.

So far the richness of the fuel mixture has been taken as constant at all altitudes. The effect of the variation of the richness is finally considered. In connection with this, the theory of the altimetric corrector for the carburation is treated of; it must, however, be modified by the results of many experimental researches.

Author.

**7. The Horse Power Rating Formula for Aero-Engines. Osamu SUGIMOTO.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 101 (1925), 609-626, with fig. and tables.]-For boat and car engines, in these days, there are several horse power rating formulas recommended by authorities. For aero-engines, however, we can hardly find any suitable formula.

Aero-engines having made great progress, it is rather difficult to express the rating in a fairly simple form.

The author at first assumed the brake mean effective pressure ( $\gamma_p$ ) as of constant value with a view to get only simple rating, that is to say, he expressed the brake horse power as the function of cylinder bore ( $d$ ), piston speed ( $S$ ), and no. of cylinder ( $N$ ), and selected the constant value by careful examination of modern aero-engines.

In conclusion the writer recommends three rating formulas for Vertical and Vee, Radial, and Rotary engines. Author.

**8. Weight Estimation in the Design of the Aeroplane. Taitirō OGAWA.** [*"Zatsuroku"* of Aeronaut. Research Inst. Tōkyō Imp. Univ., **8** (1925), 1-23, with diag. and tables.]—The paper is not complete. In the present issue, only the weight estimation of aeroplane propellers is discussed. The actual weight of some ninety aeroplane propellers is compared with that estimated by several empirical formulae. In the formulae so far proposed, of the type  $W_p = C_1(HP)^{\frac{1}{2}}$ , and  $W_p = C_2(D)^3$ , the coefficients  $C_1$  and  $C_2$  were determined so as to give the smallest possible error of estimation. Beside these improvements in the coefficients, a new type of formula,  $W_p = C_3(HP)^3$ , is recommended by the author as giving the true tendency of weight increase. Using this formula we can estimate with a small percentage of error when the type of propeller is definitely given. Even if this is not the case, the estimation can be made with a far smaller error compared with what is expected from the use of the formulae so far proposed.

The formulae of the type  $W_p = C_4 \left( \frac{HP}{n^2 V} \right)^{\frac{3}{4}} \times 10^6$  and  $W_p = C_5(HP)$ , though recommended by the authorities of aeroplane design, were rejected as inadequate for this purpose. For the percentages of propeller weight to the engine weight and to the total machine weight, which have often been given as constant, the author finds the relations:— $\frac{W_p}{W_e} = C_6(HP)^{-\frac{1}{2}}$   $\frac{W_p}{W} = C_7(HP)^{-\frac{3}{4}}$ . All these estimation formulae have error ranges of  $\pm(40\sim50)\%$ . For the present the paper deals only with two-bladed propellers of wood, because it has been very difficult to obtain sufficient data to enable other categories, i.e., four-bladed and metal ones, to be included. K. K.

**9. On Experiments with Wing Spars (Japanese). Jūichirō OKADA.** [*"Zatsuroku"* of Aeronaut. Research Inst. Tōkyō Imp. Univ., **8** (1925), 43-52, with fig. and tables.]—The object of the experiments is (1) to investigate whether the bending or the crushing strength of the materials can be taken as the breaking strength of the wing spars, and (2) whether we can use the mean value of the moment of inertia of the section in the theorem of three moments, when it varies along the span, or not.

The first half consists of a discussion of the theorem of three moments with end thrust, and the simplified one is deduced from that due to Berry. The latter half contains the experimental results with five kinds of actual wing spars. The conclusions, so far as the experiments go, are that for moderate change of section, the moment of inertia can be considered as constant or the mean value can be used, and that the bending strength can be taken as the ultimate strength of the spars if the compressive stress is under 15% of the bending fibre stress. Author.



**10. Theory of Airscrews** (Japanese). **Sandi KAWADA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., **10** (1925), 137-157, with fig. and tables.]—The theory is based on the assumption that the number of blades of the airscrew is very large.

Then upon the analogy of the vortex theory of aerofoil together with the consideration of the momentum relation, the magnitude of so-called "inflow velocities" was obtained in a simple form

$$W_a = \frac{NI'}{4\pi V}, \quad W_t = \frac{NI'}{4\pi r}$$

where  $N$  Number of blades,  
 $I'$  Circulation of the blade,  
 $V$  Velocity of advance,  
 $W_a$  Axial inflow velocity,  
 $W_t$  Tangential inflow velocity.

The profile resistance of the blades was also taken into consideration.

It was found that the relation between the effective angle of incidence  $\alpha$  and the apparent angle of incidence  $i$  of blade element was

$$\alpha = i - \frac{NI'}{4\pi Vr} \times 57.3$$

As an application of the theory the distribution of circulation corresponding to the maximum efficiency was sought, using the calculus of variation.

Lastly the comparison of the theory with actual experiments has shown a good coincidence. Author.

**11. On the Total Resistance of Spheres** (Japanese). **Zaizō AGA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., **12** (1925), 256-264, with fig. and tables.]—This is a summary of experiments on the total resistance of spheres, falling down or rising up in viscous fluids. The results of the experiments are compared with those in the wind tunnel made by Dr. C. Wieselsberger, Göttingen, and a remarkable agreement of the resistance coefficients is found if they are considered as a function of Reynolds' number. Author.

**12. Tandem Airscrew and Contra Propeller** (Japanese). **Sandi KAWADA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., **12** (1925), 238-250, with fig. and tables.]—Tandem and contra arrangements of airscrews are discussed.

Upon the assumption that the distribution of circulation round the blade is that corresponding to the maximum efficiency, it was found that when two airscrews are driven by the same kind of engine the maximum efficiency obtainable by the rear airscrew of the tandem arrangement is always inferior to the front (solitary) airscrew for the same working condition, and that the opposite direction of rotation is preferable to the same direction from the view point of efficiency.

The screw with contra propeller which is utilized sometimes for marine propulsion was investigated with the result that it will certainly ameliorate the efficiency of the ship screw but for aircraft it will not show much advantage. Author.

**13. Helicopters.** **Sandi KAWADA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., **13-15** (1925), 274-293, 321-323 and 379-383, with fig. and tables.]

—In the first part a theory of an airscrew at a fixed point is developed—which strictly speaking only holds when the circulation is uniform.

This being an extension of the author's previous paper on the theory of airscrews, it is based on the conception of vortex.

A remarkable result obtained is the independency of the effective angle of incidence upon the rate of revolution.

The second and third parts consist of the dynamics of flight of helicopters. Horizontal flight and climbing are here investigated.

The following conclusions have been reached:

i) The resistance of a helicopter to horizontal flight is very small and a slight inclination of the axis of the airscrew will suffice to overcome the resistance.

ii) A helicopter having moderate power and dimensions will be able to possess tolerable height of ceiling and climbing speed.

Author.

**14. *Experimental Research on the Air Flow through the Poppet Valves*** (Japanese). **Keikichi TANAKA** and **Toyoaki ŌHINO**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., **17** (1925), 443-492, with fig. and tables.]—With water, experimental researches upon this subject have often been reported by many authorities. With air, however, the only investigation is that of the National Advisory Committee for Aeronautics in 1918. As a problem of airplane engine design, it is necessary to have more accurate information upon this subject.

In the present paper, being the first report, the authors describe (1) the apparatus of their experiments and the method of measurement of the air flow quantity; (2) one part of the flow characteristics of the poppet valve i.e., the relation between the valve lift, the pressure drop, the flow quantity and the coefficient of efflux; and (3) the comparison of these characteristics of three similar valves of different sizes.

Authors. .

**15. *Recovery of Volatile Solvent in Dope Room*** (Japanese). **Zenjirō TAMAMIYA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., **13** (1925), 313-315.]

**16. *On the Utilization of Unused Lubricating Oil*** (Japanese). **Zenjirō TAMAMIYA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., **13** (1925), 316-317.]

## TECHNOLOGY OF ORDNANCE (1—8).

**1. Functional Resistance used in Firing Apparatus** (Japanese). **Reikichi TADA.** [J. Ord. & Exp., XVIII., 4 (1925), 191-216, with fig.]—This paper consists of four chapters of which the first is introductory. In chapter II the author gives full accounts concerning the theory of functional resistances.

In chapter III the combination of functional resistances is dealt with in two different ways, one of which is the coincident method and the other the zero method. In chapter IV their design is discussed in detail but no practical examples are given.

T. M.

**2. On the Measurement of High Pressures by the Variation of Electric Resistance of Metals** (Japanese). **Hatsutarō SUZUKI.** [J. Ord. & Exp., XVIII., 4 (1925), 217-224, with fig. and tables.]—A coil made of manganin wire, having a resistance of 100 ohms at 15° C. in the air, is put in a steel cylinder filled with dynamo oil and connected to a hydraulic press which is capable of giving the required pressure. The ends of the coil are inserted in one of the arms of a Wheatstone bridge. By this arrangement the author measured hydro-static pressures up to 100 Kg/cm<sup>2</sup> at temperatures between 5° and 35° C. and obtained the following empirical formula:—

$$\frac{r-r_o}{r_o}=ap+bp^2$$

where  $p$  = pressure applied

$r$  = resistance corresponding to  $p$

$r_o$  = „ when  $p$  is zero

$a$  and  $b$  = certain constants determined by experiments.

The results of a similar experiment with platinum wires are also given.

T. M.

**3. On the Measurement of the Velocity of Projectiles in the Barrel of a Rifle** (Japanese). **Kisaburō ŌSAKA.** [J. Ord. & Exp., XIX., 1 (1925), 35-42, with fig.]—Eight small holes were drilled in the barrel for a length extending from the point where the head of the projectile is situated when loaded, to the muzzle, and screw plugs insulated from the barrel were inserted into the above holes. When the projectile passed under these plugs, electric circuits were made successively and marked spots on a film of an oscillograph rotating uniformly at a definite high speed. The distance between two successive plugs and the speed of revolution of the film being known, the velocity of the projectile in the barrel could be obtained. The experiments with this apparatus showed that the velocity increased rapidly as the projectile advanced along the barrel until two-thirds of the length was reached and then gradually approached to a certain value.

T. M.

**4. The Motion of Sinkers, Part I** (Japanese). **Tamotsu AOKI.** [J. Ord. & Exp., XIX., 2 (1925), 93-122, with diag., fig. and tables.]—The first chapter contains a general description of sinkers. The next five chapters are entirely devoted to the

study of the motion of sinkers including the equations of motion and their solutions both analytically and graphically. A numerical example and several notes are given in the last two chapters. T. M.

**5. *A Study of the "Kick" of Rifles*** (Japanese). **Tamotsu AOKI** and **Shinji ICHINO**. [Bull. Military Arsenal, III., 9 (1925), 599-611, with fig. and tables.]—The reaction of rifles has hitherto been compared crudely by the sensation of shoulders, but in this study it has been precisely measured by means of piezo-electricity. The apparatus consisted of two quartz plates and a string galvanometer, the motion of which was photographed on a sensitive film rolled round a drum revolving uniformly. The authors observed thereby the rapidly changing pressure of the reaction when a rifle is supported (1) by a shoulder and (2) by a rigid body. The observation showed that in the former case the pressure reached a maximum in a relatively long time (0.00352 second) and then gradually decreased to zero, while in the latter case the time interval was reduced to one-third of the former. T. M.

**6. *On Autofrettage*** (Japanese). **Shimakichi NISHIHAMA**. [J. Soc. Mech. Eng. Tokyo, XXVIII., 100 (1925), 517-531, with fig. and tables.]—Some experimental investigations on the subject by the author are described with the history and the various theories of autofrettage.

The author points out that the maximum shearing stress theory is the most probable one. K. K.

**7. *On the "Limit-Gauge" System for Interchangeability*** (Japanese). **Takuo GODŌ**. [J. Ord. & Exp., XVIII., 5 (1925), 253-282, with fig., pl. and tables.]

**8. *On the Relation between the Critical Angle of Departure and the Twist of Rifling*** (Japanese). **Jūgo NAGASAWA**. [J. Ord. & Exp., XIX., 1 (1925), 1-29, with fig. and tables.]



## ELECTRICAL ENGINEERING (1—95).

1. *On the Design of Telephone Transformers by the Help of Complex Permeability* (Japanese). **Kinjiro OKABE**. [J. I. E. E. Japan, **437** (1924), 1101–1111, with fig.]—The various values of complex permeability, which were obtained when the number of iron sheets and the number of exciting coils were varied, are given.

They are obtained by the use of a complex permeability bridge introduced by Nukiyama and Shōji. Next some relations are given, which are necessary for the design of telephone transformers by the help of complex permeability.

The experimental results are furnished.

Author.

2. *On the Applications of "Sine Diagram"* (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **437** (1924), 1112–1113, with fig.]—The writer describes a new graphical method of finding the integral  $\int I(\theta) \sin \theta d\theta$ . The principle of this method is simply that the curve  $I(\theta)$  is graphed on a sheet of "Sine Diagram," as the writer calls it, in which  $I(\theta) \sin \theta$  is plotted as a function of  $\theta$ . As some examples of application, the determination of the mean spherical candle power of light flux and the graphical analysis of harmonics are illustrated.

Author.

3. *Effect of Shielding Wires upon the Interference Caused by Magnetic Induction* (Japanese). **Teiji MICHIDA**. [J. I. E. E. Japan, **437** (1924), 1122–1131, with fig.]—Some tests have been made with power transmission lines of the Tokyo Electric Light Co. (110,000V and 154,000V) to see the effect of shielding wires upon the magnetic induction to the telephone and telegraph circuits. In the present paper, these results are described and compared with those obtained from theoretical calculation, the method of which is also described.

Author.

4. *A Linear Frequency Bridge* (Japanese). **Kanesaburō KUROKAWA** and **Takeji HOASHI**. [J. I. E. E. Japan, **437** (1924), 1132–1133, with fig.]—A bridge, composed of resistances in one pair of opposite arms and of a capacitance and an inductance in another, each of the latter two having a resistance in series, is described as a new device to measure the frequency of alternating currents. The balance is obtained by adjusting the two resistances in series with capacitance and inductance. Then the frequency is directly proportional to the resistance in the inductance arm. Thus the bridge is called a "linear frequency bridge." By properly selecting the circuit constants of the bridge, the frequency may be given directly by the number of ohms of the resistance or any multiple thereof. In the appendices modifications of two bridges, given respectively by M. Wien and by Mathes and Cone, are described.

Authors.

5. *On the Vibrating Coil Type Receiver and its Vibrating System* (Japanese). **Katsuichirō KOBAYASHI**. [J. I. E. E. Japan, **437** (1924), 1196–1205, with fig.]—The motional impedance measurements of the vibrating coil type telephone

receiver as not simply a sounder, but as a measuring instrument in the study of acoustics, are described.

Some factors of the design to obtain a satisfactory type of telephone receiver for acoustic research are studied experimentally. Author.

**6. On the Alternating Resistance of Transmitters** (Japanese). **Kanesaburō KUROKAWA**. [J. I. E. E. Japan, 438 (1925), 34-44, with fig.]—Static and dynamic tests of a microphone transmitter are described. For a transmitter kept quiet, both constant voltage and constant current tests were performed by noting the variation of current or voltage with respect to time and therefore that of static resistance.

For dynamic tests, vibrations were given to the transmitter acoustically from a telephone receiver carrying an alternating current of audible frequency. Moreover, a direct current was sent to the transmitter through a high resistance. Continuous and alternating voltages which thus appeared across the terminals of the transmitter were measured with D.C. and A.C. potentiometers. Thus the no load dynamic characteristics are obtained by varying the alternating current through the driving receiver, its frequency or the direct current of the transmitter. Author.

**7. Frequency Characteristics of Inductively Coupled Two Circuits** (Japanese). **Kanesaburō KUROKAWA** and **Tomoyoshi HIROTA**. [J. I. E. E. Japan, 438 (1925), 90-116, with fig.]—The vector ratios of two quantities among voltages, currents and charges of inductively coupled two circuits are calculated, and their properties under variable frequencies are investigated by tracing their vector loci.

Authors.

**8. Constant Speed Induction Motor** (Japanese). **Tatsuichirō ISONO**. [J. I. E. E. Japan, 439 (1925), 117-126, with fig.]—The author explains a combination of an induction motor and a special frequency changer to keep the speed constant and independent to the primary frequency, primary e.m.f. and the mechanical load. The idea of the principle is to keep the difference between the primary frequency and secondary frequency constant by a special frequency changer. Author.

**9. On the Practical Data of Economical Spans** (Japanese). **Nobuo TAGAWA**. [J. I. E. E. Japan, 439 (1925), 149-158, with fig.]—The author deals with the economical spans of the transmission lines at various voltages and finds those based on the present conditions in Japan; such as: 930 ft. for 154,000 V; 730 ft. for 77,000 V line (with suspension type insulators); and 690 ft. for 77,000 V line (with pin type insulators). M. S.

**10. Theory of the Kenotron Rectifier Circuits** (Japanese). **Hidetsugu YAGI** and **Takashi ONO**. [J. I. E. E. Japan, 439 (1925), 159-172, with fig.]—The authors treat of the kenotron rectifier circuits by simply attributing to the kenotron the property of preventing any passage of reverse current, and assuming the internal resistance to be a constant quantity.

For half wave rectification, the D.C. voltage can be represented during the forced oscillation by the sum of exponential terms and a trigonometrical term, and during the free discharge of the condenser by exponential terms.

In the case of double wave rectification, the relations are similar to the above so long as no overlapping takes place. But if the currents through both kenotrons happen to overlap with each other, as is usually the case, the A.C. source becomes short-circuited through the kenotrons and the current through the load is again the sum of exponential terms and a sine term.

The factors relating to the suppression of ripples in D.C. voltage are discussed, the most efficient means being the use of a larger condenser and higher frequency.

The kenotron rectifier circuit patented by M. Latour is finally described and is dealt with in a similar manner. Authors.

**11. *On the Theory of Dielectric Hysteresis Loss in Fibrous Insulating Materials, Report II*** (Japanese). **Yotsuo TORIYAMA**. [J. I. E. E. Japan, **439** (1925), 173-181, with fig.]—As the fibres in fibrous insulating materials are not complete insulators, we can consider that such incomplete fibres form a large number of "floating" leaky small condensers. From this consideration the author deduces the equation of the power factor. He also discusses the effects of frequency and temperature upon the power factor and the dielectric hysteresis loss. Author.

**12. *On the Theory of Tirrill-regulators*** (Japanese). **Jūsuke ŌKŌCHI**. [J. I. E. E. Japan, **439** (1925), 182-204, with fig.]—The author discusses the effect of the condenser connected in parallel to the relay contact of a Tirrill-regulator upon the exciting current and upon the spark which occurs at opening and closing of contact. Many oscillograms and Braun-tube figures are given. M. H.

**13. *The Emission of Positive Ions from a Fresh Wire of Nickel-Chromium Group, Heated in the Atmosphere*** (Japanese). **Hiroshi MIYABE**. [J. I. E. E. Japan, **439** (1925), 205-212, with fig.]—In a horizontal brass tube a piece of calido wire is stretched and a steady e.m.f. of dry cells is applied between the two, with the negative terminal connected to the tube. If a heating current is sent through the wire, a positive ionic current begins to flow from the wire to the tube electrode. The author investigates the characteristic features of this positive ion emission of calido wire with respect to temperature and applied voltage. Characteristic curves thus obtained show very regular forms as compared with previously published results on platinum and other metals. M. H.

**14. *On the Jumping Phenomena and the Imaginary Coupling in the Coupled Circuits*** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **440** (1925), 227-258, with fig.]—The author discusses theoretically and experimentally the so-called "Zieherscheinungen" such as are observed in the two mutually coupled circuits comprising a triode valve oscillator. He refers to the falling oscillation characteristic for the case of electrostatically coupled circuits, and to the lumped voltage characteristic of a triode valve for the inductively coupled circuits. M. H.

**15. On the Action of an Exciter Operated by Vibrating Contact Type Voltage Regulator** (Japanese). **Shintarō UDA**. [J. I. E. E. Japan, **440** (1925), 278-284, with fig.]-The author treats of the case in which the automatic voltage regulator is merely controlled by the terminal voltage of an exciter. The principal statement made is that the rapidity of an exciter action is greatly affected by the resistance of its field circuit, the required voltage, and the operating condition of the magnetic circuit of an exciter. Author.

**16. The Telephone Receiver as a Vibratory Generator.** **Kanesaburō KUROKAWA**. [J. I. E. E. Japan, **440** (1925), 285-301, with fig.]-The characteristics of telephone receivers are known as electric motors. They are, however, here studied as electric generators driven by sound.

Experiments were carried out with two receivers, coupled acoustically with a tube, one as a motor and the other as a generator. The induced electromotive force of the generator varied remarkably with the frequency, although the motor current was kept constant. It reached, in one instance, 57 millivolts for 1 milliamperes of motor current. Such a variation occurred because the apparatus used in the tests was a coupled system of two diaphragms through an acoustic tube, each having its own natural frequency or frequencies. The e.m.f. also varied somewhat in a similar manner when the length of coupling was changed, keeping the frequency constant.

When the generator was loaded with capacitance, the terminal voltage increased at first with the load current and then decreased. The current thus taken out reached 264 microamperes in one instance. For resistance load, the voltage dropped from the beginning with increase of load current. Thus the vibratory generator showed the same characteristics as alternators.

In addition, a system of two receivers with an acoustic coupling as used in the present tests, is studied in the appendix. Author.

**17. Design, Construction and Tests on an Electrically Heated Black-Body Furnace** (Japanese). **Matsujirō ŌYAMA**. [J. I. E. E. Japan, **441** (1925), 311-317, with fig.]-The paper is the report of the test results on a simplified form of Lummer and Kurlbaum type black-body furnace, designed by the author for laboratory standard of thermal radiation. Several notes for operation are added. M. II.

**18. On an Intermittent Production of Triode Valve Oscillation** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **441** (1925), 339-346, with fig.]-In a triode valve high frequency oscillation circuit, an anomalous low frequency oscillation is sometimes produced through the circuit comprising the choke coil connected in series with the d.c. source and the high frequency by-pass condenser connected in parallel to it. In the present paper the author describes the results of the experimental determination of the possible range of this anomalous phenomenon with respect to the plate voltage, the grid voltage, the filament current, the constants of the oscillation circuit, the coupling between the grid and the plate circuits, and the resistance inserted in series with the choking coil. M. II.

**19. Remarks on the Design of Audio-frequency Amplifier Transformers** (Japanese). **Shigetarō CHIBA**. [J. I. E. E. Japan, **441** (1925), 370-377, with



fig.]—The paper describes the general considerations of the design of intervalve transformers which make possible distortionless amplification over a given audible frequency range. A simple method of testing the frequency characteristic of the intervalve transformer is given. The method is applicable if the transformer has no leakage flux. If the transformer is shunted on the primary side by a non-inductive resistance the value of which is equal to the plate resistance of the valve to be coupled, the impedance measured on the same side of the transformer by an impedance bridge for a certain frequency range gives at once the measure of the variation of the voltage amplification over a given frequency range. The secondary winding must in this case be connected to the grid circuit of the valve of the next stage with suitable grid bias. The theory of intervalve transformers advanced by many authors shows that the optimum ratio of transformation is approximately equal to the square root of the ratio of the grid impedance to the plate resistance. The maximum voltage amplification per stage is then equal to half the product of the ratio of transformation into the amplification factor of the triode. It is indicated that this theory is not suitable to explain the high voltage amplification measured very often in actual tests. The equation derived in this paper shows that the voltage amplification per stage is just twice the value (maximum) derived by the old theory. The latter is erroneous since it does not take into account the variation of the secondary impedance with the ratio of transformation. This variation is not negligible when the grid circuit impedance is enhanced by the appropriate grid bias. The secondary impedance then consists mainly of the distributed capacity of the transformer winding.

Author.

**20. Transient Potential Distribution in a Transformer when its Terminal is Grounded** (Japanese). **Risaburō TORIKAI**. [J. I. E. E. Japan, **442** (1925), 387–398, with fig.]—The author studies the transient abnormal potential distribution in a transformer coil, in the case of grounding its terminal, taking into account the terminal oscillating circuit composed of capacity of bushing and lightning arrester and self induction of the choking coil, and concludes that the potential gradient may be very much greater with the oscillating circuit than without it. The greater the terminal capacity, the less is the dangerous potential gradient.

Author.

**21. On the Power Diagram of Transmission Network** (Japanese). **Fumiki KITŌ**. [J. I. E. E. Japan, **442** (1925), 399–410, with fig.]—Adopting the idea of a power circle diagram originated by C. L. Fortesque and C. F. Wagner (J.A.I.E.E., Feb. 1924), the author proves that for any transmission network two or more condensers the power diagram consists of a chain of circles, the number of circles being equal to that of the condensers used.

M. H.

**22. On the Ballistic Energymeter Designed for the Purpose of Measuring the Spark Energy** (Japanese). **Jūsuke ŌKŌCHI** and **Kenichi INAGAWA**. [J. I. E. E. Japan, **442** (1925), 411–420, with fig.]—The theory and the experimental results of the ballistic energymeter are described. The meter was designed by the authors for the purpose of measuring the energy of an instantaneous high voltage and small current such as the energy of an electric spark.

It is shown experimentally that this meter can measure accurately energy of the order of some hundred ergs with the error of several per cent.

The meter can also be used for the study of the inflammability of explosive gas-mixtures and for many other problems of spark and spark ignition.

Authors.

**23. *The Johnsen-Rahbek Electrical Attraction and its Application*** (Japanese). **Shigeo MOCHIZUKI** and **Shin-ichi HIROSAWA**. [J. I. E. E. Japan, **442** (1925), 421-428, with fig.]—Under direct current voltage supply, the authors deal with the adhesive force set up between a metal plate and a semi-conductor with which it is in close contact, and the resistance of such a system. In case of a plain semi-conductor, the adhesive force is only about the second power of the applied potential, in spite of the contact surfaces being polished with special care. The increase of the conductivity with increasing potential difference is chiefly due to the variation of the distribution of moisture at the interface and the electron emitted from the metal, and to not coming into more intimate contact at higher potentials, unless the contact surfaces are polished carefully. The difference of conductivity due to polarity is especially remarkable in agate. A simple telephone receiver and a transmitter have been devised applying this principle.

Authors.

**24. *On the Electromagnetic Induction upon the Aerial Telephone Cable Caused by Neighbouring Transmission Lines*** (Japanese). **Kazuho KANAYA**. [J. I. E. E. Japan, **442** (1925), 429-442, with fig.]—The author discusses theoretically the electromagnetic induction upon the aerial telephone-cable, which has been adopted in Japan recently for long distance telephone circuits, caused by grounding of neighbouring transmission lines.

Author.

**25. *A Thermoradiometer of Thermopile Principle*** (Japanese). **Matsujirō ŌYAMA**. [J. I. E. E. Japan, **442** (1925), 490-496, with fig.]—"Thermoradiometer" is a general name given by the author to the instrument, which measures intensity of thermal radiation at any given direction, or radiant energy through unit area normal to the direction. Hence, such radiometric instruments as the radiometer, radiomicro-meter, bolometer, etc. can be considered as special types of thermoradiometer. In this paper, a newly designed thermoradiometer of thermopile principle is described. This instrument is made for the purpose of measuring radiant energy at any direction from electric heaters or other radiators.

The principal part is nothing but a thermopile of which the cold and hot junctions are set symmetrically inside its case, in order to obtain a steady zero point.

The sensibility and time for establishing a steady state in action can be varied over a considerable range by designing the form and size of conductors between cold and hot junctions.

One of the experimental instruments designed by the author has a sensibility of 80 milli volt watt per sq. cm.

Author.

**26. *Effects of the Metal Surfaces on Measurement of Electric Conductivity of Semi-Conductors*** (Japanese). **Kinjiro OKABE**. [J. I. E. E. Japan, **443** (1925), 526-531, with fig.]—The author investigates the effects of the metal surfaces of the terminal metals on the measurement of electric conductivity of semi-conductors. He gets the various values of conductivity about the same semi-conductor only by

changing the kind of terminal metals. The surface of the terminal metal with a low melting point shows a larger value of conductivity than that with a high melting point.

Author.

**27. Rectifying Action of Metal-Contact in Motion** (Japanese). **Kinjirō OKABE**. [J. I. E. E. Japan, **443** (1925), 532-534, with fig.]—Two different metals, which are brought in contact, present no stable rectifying action, but if one of them is in motion, a remarkable rectifying action at the contact point can be recognized. The author investigates the phenomena for (a) direct contact and (b) indirect contact through the surface gases.

M. H.

**28. The Behaviour of an Induction Type Protective Relay with Special Reference to its Floating Phenomenon** (Japanese). **Hidetsugu YAGI** and **Hiroshi HINENO**. [J. I. E. E. Japan, **444** (1925), 545-555, with fig.]—The effect of temperature upon the time limit of an induction type relay is investigated and the results show that the effect is remarkable, especially so for a small ampere setting. Then, the motion of the relay disc under intermittent over-loads is fully studied and it is shown that the time-limit may often become quite uncertain due to its floating effect.

Authors.

**29. On the Grounding of a Long Distance Transmission Line Compensated through Petersen Earth Coils** (Japanese). **Takashi OHTSUKI**. [J. I. E. E. Japan, **444** (1925), 574-588, with fig.]—The present paper offers a supplementary extension of the previous one due to the same author [J. I. E. E. Japan, **434** (1924), 803-847]. At first the author explains physically the action of earth coils on a grounding accident of a transmission line. Then a practical line-length capable of being compensated through earth coils is suggested. Finally the effect of the third harmonics component in the working e.m.f. on the earth current is considered.

M. H.

**30. Note on the Calculation of Tooth Pulsation in Rotating Machines** (Japanese). **Shigeo MOCHIZUKI**. [J. I. E. E. Japan, **444** (1925), 599-604, with fig.]—The author calculates the magnitude of the tooth pulsations for rotary machines in which both the stators and rotors are slotted. He proposes new empirical formulae and compares the results obtained by means of these formulae with those calculated by the approximate formula due to T. Spooner. The saturation effects and the effects of short-circuited windings are not considered.

M. H.

**31. On the Variations of Frequency and Amplitude of the Oscillations Generated by Triode Valve Oscillators** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **444** (1925), 605-613, with fig.]—The frequency of oscillation of an audio-frequency triode oscillator is different from the natural frequency of the oscillation circuit, as calculated by the formula  $\omega_0^2 = 1/LC$ . The author explains the phenomenon from the point of view that the grid current is the principal cause of the variation. The author considers the case only in which the instantaneous value of the plate potential is throughout its pulsating cycle always higher than the grid potential, so that the grid current may be considered as a function of the grid voltage only. The

actual frequency  $\omega$  is related to the simple theoretical frequency  $\omega_0$  by a simple equation. Then the oscillation characteristics are observed dynamically by means of the Braun tube oscillograph. It is ascertained that the hysteresis loops, which become apparent when either the frequency or the intensity of the oscillation is increased, are due to the coming into existence of the grid current. Author.

**32. On the Synchronization of Rotary Converters** (Japanese). **Yukito TAKAHASHI**. [J. I. E. E. Japan, **445** (1925), 639-650, with fig.]—The author discusses the starting conditions of synchronous converters and reaches the conclusion that the best method of starting is to switch in on the high tension side taps of the transformer. He also makes some remarks on the polarity reversal, and the operation of automatic synchronizing by polarized relay. M. H.

**33. On the Electro-Acoustic Transformer** (Japanese). **Katsuichirō KOBAYASHI**. [J. I. E. E. Japan, **445** (1925), 651-663, with fig.]—When both the terminal impedances, electric impedance of electric source and acoustic impedance of acoustic radiator, are given, the condition which makes the acoustic power maximum, can be derived, and the maximum acoustic power becomes larger the higher the electro-mechanical efficiency. When a moving coil type telephone receiver is used as the electro-mechanical transformer, the electro-mechanical efficiency reaches its maximum at a certain condition, and this maximum efficiency is limited by the degree of uniformity of acoustic power in the range of frequency required for faithful reproduction of speech.

A procedure for the design of an electro-acoustic transformer, taking into account the efficiency and frequency distortion for reproduction of speech, is proposed.

Author.

**34. On the Theory of the Triode Valve Amplifier and the Measurement of the Characteristic Constants of the Triode Valve** (Japanese). **Heiichi NUKIYAMA** and **Shigeo KITTA**. [J. I. E. E. Japan, **445** (1925), 664-678, with fig.]—In the present paper the theory of the characteristic of a triode valve for alternating current is based on the assumption that the alternating current of the grid and the plate can be expressed as complex linear functions of the alternating potential of these terminals. A general theory to determine the four valve constants is given. In a particular case the valve constants are reduced to three, i.e., input impedance, plate resistance and amplification constant. By measuring the amplification ratio by alternating current potentiometer, these three valve constant are determined. A direct potentiometric method to determine the amplification constant is also given. The method is checked by experimental results. Authors.

**35. A Vibrating Contact Type D.C. Automatic Voltage Regulator Sensitized by Means of Thermionic Tubes** (Japanese). **Masaharu HOSHIAI**. [J. I. E. E. Japan, **445** (1925), 679-708, with fig.]—The author tries to raise the sensibility of relay systems of the vibrating contact type D.C. automatic voltage regulator by means of thermionic tubes. In the main control magnet circuit, the magnetron tube is inserted, raising the effective sensibility of the circuit by its amplifying action, and in the relay magnet circuit, audion tubes are used to lessen the time lag of the relay



action due to the electrical inertia of the circuit. Various mechanical and electrical conditions of the magnetron suitable for this purpose are also discussed.

In the appendices, (1) after discussing the necessary conditions for an exact expression of the magnetization curve of the generator, an empirical formula:

$$\phi = a + b i_f + c \tanh d(i_f - g)$$

is recommended; (2) the pulsations of the voltage and the currents of the D.C. generator with vibrating contact type voltage regulator are discussed for various load conditions.

Author.

**36. Double Delta Connection by Three Single Phase Transformers with Two Secondary Windings** (Japanese). **Matsujirō ŌYAMA**. [J. I. E. E. Japan, **445** (1925), 709-715, with fig.]—In double delta connection of three single phase transformers with two secondary windings, we can derive simultaneous loads from the full-voltage and half-voltage taps. The relation and limit of these loads for the safe operation of transformers are calculated and the equivalent network for this connection is also given for the purpose of grasping the idea of voltage and current-distribution.

Author.

**37. Experimental Study on the Voltage Amplification Ratio of Audio-frequency Amplifiers** (Japanese). **Shigetarō CHIBA** and **Shigeo KITTA**. [J. I. E. E. Japan, **445** (1925), 716-732, with fig.]—The voltage amplification ratio of various types of audio-frequency amplifiers is measured by an alternating current potentiometer. The result gives the amplification ratio in its magnitude as well as its phase angle for 1 to 3 stage amplifiers of resistance, reactance, and transformer coupling. Their frequency characteristic curves (the amplification ratio versus the frequency) and amplitude characteristic curves (the amplification ratio versus the amplitude of the input voltage) are given.

With resistance and reactance amplifiers no distortion occurs due to the non-linear character in their frequency and amplitude characteristics.

With transformer amplifiers these characteristics are far from ideal unless special attention be paid to the design of the transformers. A certain amount of the negative bias must be given to the grid of the triode in order to obtain the high amplification ratio. Without the grid bias, the input impedance of the grid-filament decreases to a large amount to the detriment of the amplifying action of the set.

The decrease in the input impedance when the input voltage is too high is also the case of the amplitude distortion. Various methods to prevent this distortion are suggested in the paper. The increase of the negative value of the grid bias is one of them. This method introduces, however, another cause of distortion, as the working range of the triode is removed to the lower part of its characteristic. In such a case the "push-pull" arrangement may be employed with advantage.

Authors.

**38. On the Impedance of Audio-frequency Amplifier Transformers** (Japanese). **Shigetarō CHIBA** and **Shigeo KITTA**. [J. I. E. E. Japan, **445** (1925), 733-738, with fig.]—The impedance of audio-frequency amplifier transformers is measured by the bridge method, and its polar diagram is given. The magnitude of this impedance will be changed by the effect of the d.c. magnetisation of distributed capacities at various parts and by the current flowing in the secondary of the transformer. The

change in the impedance due to the secondary current is prevented when the secondary grid circuit has a grid bias or a condenser shunted with high resistance. Authors.

**39. On the Decomposition of the Poynting Vector for the Expression of the Rate of Flow of Electromagnetic Energy** (Japanese). **Heiichi NUKIYAMA**. [J. I. E. E. Japan, **445** (1925), 739-748, with fig.]—It is shown that the Poynting vector

$$\dot{\mathbf{P}} = \frac{c}{4\pi} (\dot{\mathbf{G}} - \dot{\mathbf{G}}_0, \dot{\mathbf{H}} - \dot{\mathbf{H}}_0)$$

may be considered to represent the rate of flow of energy through unit area even when there is the phenomenon of electric and magnetic hysteresis. The Poynting vector is then decomposed into

$$\dot{\mathbf{Q}} = \frac{c}{4\pi} \text{curl} (\mathbf{V} \nabla \Omega - \mathbf{V} \dot{\mathbf{H}}_i + \Omega \dot{\mathbf{G}}_q)$$

and

$$\dot{\mathbf{R}} = \mathbf{V} \dot{\mathbf{i}} + \Omega \dot{\mathbf{j}} + \frac{c}{4\pi} [\dot{\mathbf{G}}_q \dot{\mathbf{H}}_i]$$

of which the latter may take the place of the Poynting vector to represent the surface density of the rate of flow of electromagnetic energy. The difference in conception of the actual state of flow of energy when we use either the Poynting vectors or the  $\dot{\mathbf{R}}$  vector is compared for (a) superposed electrostatic and magnetostatic field; (b) transmission line composed of two parallel wires; (c) electromagnetic wave field. It is concluded that it is perhaps more proper to adapt the  $\dot{\mathbf{R}}$  vector instead of the Poynting vector to represent the surface density of the rate of flow of energy, at least in practical cases, and it is further explained that this conception will not be against the idea of continuity of phenomena which is the basis of Maxwell's theory. Author.

**40. Measurement of the Natural Frequency of Single Turn Coils** (Japanese). **Yūji NISHIMURA**. [J. I. E. E. Japan, **446** (1925), 773-782, with fig.]—The author proposes a new method of measuring the natural frequency of single turn coils. A two-valve short wave generator radiating steady waves of 250-meter long is set at a distance of 10 meters from a receiver and the coil under test is placed in front of the latter. Then the dimension of the coil under test is varied and the intensity in the receiver system is observed. The change of intensity of the received energy is caused by the absorption and refraction by the coil, and the results clearly indicate its resonance point. The coils tested are equilateral triangle, square and circle, each made of a single closed turn of B. S. # 10 wire. Afterwards the coils are cut at a point and a gap of 1 cm. is formed. These open turns show resonance of the fundamental, the second and third harmonic oscillations. M. H.

**41. On the Measurement of Natural Frequency of Coil with Ultra-Radio Waves** (Japanese). **Hidetsugu YAGI**. [J. I. E. E. Japan, **446** (1925), 783-787, with fig.]—The author discusses the method of determining the natural wave length of single turn coils of various shapes, proposed by Yūji NISHIMURA [J. I. E. E. Japan, **446** (1925), 773-782] and proposes some improvements. M. H.

**42. Self-Excitation of Alternators for Unbalanced Condensive Load** (Japanese). **Masakazu TAKAHASHI**. [J. I. E. E. Japan, **446** (1925), 788-804, with fig.]—This paper is a further study upon "Charging of the Transmission Line and Self-Excitation of Alternators," by the same author [J. I. E. E. Japan, **432** (1924)]. The author applied the principle of superposition to the unbalanced three phase condensive load and obtained the method for the volt-ampere charging characteristics and the saturation curve excited by an unbalanced armature leading current by using the method he previously introduced. The self-excitation of alternators for an unbalanced condensive load may be clearly explained by the intersection of those two curves. In an actual case such a condition occurs when one line of an isolated three phase transmission system is grounded at the charging condition. The Petersen earth coil is also to be recommended for the avoidance of such an abnormal condition of self-excitation, as well as for the use of the suppression of arcing ground. Author.

**43. The Influence of Sleet upon the Long-Span Overhead Transmission Line** (Japanese). **Teizō ENOMOTO**. [J. I. E. E. Japan, **446** (1925), 831-839, with fig.]—Double-circuit towers for extra-high tension transmission lines, which are generally employed at present, have the conductor arrangement such that three wires in one circuit are placed nearly in a vertical plane. The author discusses the possibility of frequent troubles of line-to-line flash-over, if such ordinary type towers be used in a mountain district of deep snow-fall with long-tower-span, caused by the jumping-up and resilience of one conductor owing to a sudden fall of sleet, or by the unbalanced loading between conductors in parallel. The author investigates the minimum distance between the vertical planes containing each conductor. Author.

**44. Water-Wheel Type Thermionic Vacuum Tube** (Japanese). **Kinjiro OKABE**. [J. I. E. E. Japan, **446** (1925), 840-843, with fig.]—This paper describes a new type of thermionic vacuum tube, which has a falling character, by the use of electron reflection, secondary emission and magnetic field. There are many differences between this tube and "Dynatron" in construction and characteristics. This tube has a water-wheel type grid. Author.

**45. Dielectric Hysteresis Loss and Insulation Resistance in Homogeneous Dielectrics** (Japanese). **Yotsuo TORIYAMA**. [J. I. E. E. Japan, **447** (1925), 851-858, with fig.]—It is a well known fact that there is dielectric hysteresis loss in homogeneous dielectric. The author explains this phenomenon by the conception of space charge. The specific resistance of an insulator decreases with the potential gradient and also with increase of thickness at a constant potential gradient. The author divides the resistance in dielectrics into two parts, that is, one part is the resistance of the insulator itself, and the other part is the resistance between the insulator and the electrodes. He calls the latter the "surface resistance," and explains the above mentioned two phenomena by this consideration. Author.

**46. On the Oscillations Produced by Means of a Duplex Valve Oscillator** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **447** (1925), 859-869, with fig. and pl.]—The duplex valve oscillator is the valve oscillator containing two oscillation circuits. The natural frequencies differ so much from each other that

the impedance of the one circuit at the frequency, which is given by the constants of the other circuit, is negligibly small compared with the internal resistance of the valve.

The author discusses the stability of the oscillation produced by means of such a duplex oscillator. For example, when the capacity of the variable condenser in the high frequency oscillation circuit is varied gradually, a sudden change in the frequency of the oscillation takes place at two points.

The author explains such a jumping phenomenon by taking into consideration the variation of the internal resistance of the valve, which is dependent upon the amplitude of the oscillating plate current. Moreover, the author considers the case where two oscillations, one of high frequency and the other of low frequency, can build up simultaneously, and shows some experimental results obtained by means of the Braun tube oscillograph.

Author

**47. *Balancing Device of Alternating Current Source for Measuring Purposes* (Japanese). Kazukiyo OGAWA.** [J. I. E. E. Japan, **447** (1925), 889-902, with fig.]—The alternating current source for measuring purposes is usually unbalanced against the earth. The equivalent circuit of the unbalanced alternating current source is first considered and the idea of the physical and the earth circuit is given. By the aid of this idea, it is discussed whether we can make any alternating current source balanced against the earth by connecting a suitable network between the source and the load. The ordinary transformer is proved not to be suitable for this purpose on account of the distributed capacity between the primary and the secondary coils. Two kinds of balancing transformers are described which were wound by the author with good results. Finally it is noticed that the retardation coil, if connected in shunt with the source and its middle point earthed, has slightly the effect of reducing the unbalance of the source.

Author.

**48. *Consideration of the Stiffness of the Three Phase Series Commutator Motor*. Teruo UYEDA.** [J. I. E. E. Japan, **447** (1925), 903-917, with fig.]—The stiffness, in this paper, means the ratio of the magnetomotive force of the rotor to that of the stator. The author discusses the stiffness of the three phases series commutator motor of the doubly fed type. The relation between the stiffness and the brush angle on the phase compensation are explained generally. Experimental results are shown regarding the saturation effect of the rotor transformer under the constant stiffness and the constant brush angle, and next the effect of stiffness under the constant angle on the various characteristics of the machine.

Author.

**49. *On the Behaviour of the Third Harmonic Current on a Normally Operated Three-phase Line*. Takashi ÔTSUKI.** [J. I. E. E. Japan, **447** (1925), 932-937, with fig.]—The components of the third harmonic current on a normally operated three-phase line are discussed for various transformer-connections and neutral grounding system. When the neutral point either on the sending end or the receiving end is grounded in some way there exists more or less always a third harmonic charging current in the line, depending on the neutral grounding system, the line-constants and the amount of the third harmonic induced e.m.f. in the respective windings. The charging current may be capacitive or inductive according to the line-length and neutral grounding systems adopted, as shown in the previous supplementary paper by the same author [J. I. E. E. Japan, **444** (1925)] relating to the earth coils compensation.



On grounding both the end-neutrals, the third harmonic circulating current through the line and earth, as well as the third harmonic component of the magnetizing current for the transformer bank at the receiving end, should be added to the above charging currents. Although it is very difficult to express the exact resultant neutral current in a simple formula, the grounding of both end-neutrals does not always increase the neutral current on the single grounding system, in regard to the respective phase relations, according to a theoretical consideration and an experimental observation. The author also discusses the resonant condition of the system with respect to the third harmonic neutral current, delivering a general equation for its charging and circulating current components. Author.

**50. Method of Symmetrical Co-ordinates and its Application to Transmission Line Problems** (Japanese). **Sadatoshi BEKKU**. [J. I. E. E. Japan, **448** (1925), 941-957, with fig.]—The present paper is a further investigation of the application of the method of symmetrical co-ordinates to transmission line problems [G. E. Rev. XXVIII, **7** (1925), 472-478]. In this paper the author specially points out that any complicated three phase network may be considered as a simple symmetrical alternator by imagining fictitious terminals at the point of fault, which simplifies the solution. M. S.

**51. Recommending the Adoption of the Shunt Wound Rotary Converter for Electric Traction** (Japanese). **Tatsuo ISHIYAMA**. [J. I. E. E. Japan, **448** (1925), 958-964, with fig.]—The author recommends the use of the shunt wound rotary converter for traction service. He investigates the amount of the voltage drop of the D.C. side of the machine and points out its comparatively small voltage regulation. M. S.

**52. On the Accuracy Test of the Synchronizing Fork** (Japanese). **Waichirō MIYAMOTO**. [J. I. E. E. Japan, **448** (1925), 1024-1034, with fig.]—A brief description is given as to the method and results of the accuracy test of the synchronizing fork, the aim of the test being to judge the propriety of the synchronizing fork as used in the calibration of the wave-meter. In the test the clock-work tachometer, designed by the author, was used. This gives fairly accurate results. Author.

**53. Theory of the Induction Type Wattmetre, II** (Japanese). **Tarō OTAKE** and **Nobuyoshi KATŌ**. [J. I. E. E., Japan, **448** (1925), 1035-1049, with fig.]—An approximate calculation of the mean torque acting on the rotating disc of the induction type wattmetre, given by the same authors in the previous paper [J. I. E. E. Japan, **426** (1924), 33-68], under the same assumptions as before is not perfect, as in its deduction the higher orders of the series were neglected in order to simplify the calculation. So in this work the mean torque is determined starting from the same assumptions as before, but neglecting no factor as was done previously. The result of this calculation shows that the mean torque can be determined by supposing the total magnetic flux concentrated at the centre of its own circular magnetic pole and the inversion of its center, instead of the centre of its own pole and the inversion of the magnetic pole as in the previous result. Authors.

**54. *A Method of Measuring the Spark Lag*** (Japanese). **Jūsuke ŌKŌCHI.** [J. I. E. E. Japan, **448** (1925), 1050-1054, with fig.]—The author proposes a new semi-empirical method of measuring spark lag, in which a non-inductive resistance and an inductance coil are connected in parallel to the spark gap and the spark lag is calculated from the instantaneous value of current flowing in the resistance-inductance circuit when the sparking voltage is applied to the gap. Some experimental verifications of the method are added. M. H.

**55. *On the Static Unbalancing of V-Connection*** (Japanese). **Masao SHIDA.** [J. I. E. E. Japan, **448** (1925), 1055-1069, with fig.]—The author investigates the unbalancing of the voltages of three terminals to the ground in a three phase V-connection of transformers and the methods of compensation by means of condensers. M. S.

**56. *Explanation of the Time Lag of Spark in Solid Dielectrics According to "Wagner's Theory"*** (Japanese). **Matsunosuke IWATAKE.** [J. I. E. E. Japan, **448** (1925), 1070-1073, with fig.]—The author applies Wagner's theory on the breaking down phenomena of solid dielectrics to the author's experimental results regarding the time lag of spark in solid dielectrics, and he finds that it holds good for various materials except mica and glass. M. H.

**57. *On the Three Phase Arc*** (Japanese). **Jūzaburo IMAMURA.** [J. I. E. E. Japan, **449** (1925), 1143-1156, with fig.]—Three phase arcs present some special features because of their inter-phase relations, and cannot be simply conceived as a group of single phase arcs. The author observes at first the rotation of the arcs by means of a stroboscope, and then the current and voltage wave forms by an oscillograph. Oscillograms are given for balanced arcs with similar electrodes and unbalanced arcs with electrodes different from each other in size, material and relative position.

The wave forms of three phase arcs, which are remarkably different from those of single phase arcs, are dependent upon the direction of the arc rotation and are also much influenced by the degree of unbalance.

Whether the supply transformers are connected in delta or star shows no appreciable difference. When iron-cored inductances are inserted in each phase, the balance can be easily established, but when the inductance is put in one or two phase only, the arcs show marked unbalance and the current through one pole becomes decidedly rectified. Which pole happens to carry the rectified current depends upon the direction of the arc rotation. Author.

**58. *On the Acoustic Impedance at the Sending End of a Conical Horn of Finite Length*** (Japanese). **Katsuichirō KOBAYASHI.** [J. I. E. E. Japan, **449** (1925), 1157-1169, with fig.]—The experimental results as well as the theoretical analysis of acoustic impedances at the sending ends of conical horns of varying length and solid angle are given. Calculations of these acoustic impedances from the dimensions of the horns and working frequency are described in detail. The theoretical results are coincident with those obtained from experiments. M. H.

**59. On the Wave Filter which can be considered as a Compensated  $\pi$  Artificial Electric Line** (Japanese). **Ken ŌKUBO**. [J. I. E. E. Japan, **449** (1925), 1170-1188, with fig.]—The author deals with the wave filter as an application of compensated  $\pi$  artificial electric line, proposed by NUKIYAMA and OKABE [J. I. E. E. Japan, **413** (1922)].  
M. H.

**60. On a Starting Method of Squirrel-Cage Induction Motor** (Japanese). **Kyōsuke HARADA**. [J. I. E. E. Japan, **449** (1925), 1189-1198, with fig.]—To improve the starting condition of the squirrel-cage type induction motor, the author has made a simple modification in the arrangement of the end rings of the rotor, so that the starting current is reduced and, at the same time, the starting torque is made comparatively large. The theory and experiment show that, by this method, the starting condition can be improved at least to the extent to which it can be effected by the use of the starting compensator.  
Author.

**61. Characteristics of an Induction Motor and its Transient Phenomena.** **Toshitarō TAKEUCHI**. [J. I. E. E. Japan, **449** (1925), 1199-1310, with fig.]—The author discusses first the general cases of transient phenomena which occur due to a sudden change of the conditions of the supply source of an induction motor and generator, and a few special cases, such as switching in, switching off, and sudden terminal short circuit, etc. Finally numerical calculations and their comparison with the experimental results are shown.  
Author.

**62. Some Theoretical Researches on the Power Limit, Synchronous Condenser Capacity and Other Characteristics of Long Distance Transmission Lines.** **Masaie HORIOKA**. [Researches, Electrot. Lab. Tokyo, Japan, **151** (1924), 1-8, with fig.]—The power limitation, the required synchronous condenser capacity and other characteristics of a long transmission line with a constant receiving voltage are calculated theoretically in the most general form. The results can be directly applied to any transmission line, the only necessary quantity for calculation being the power factor of the so-called "apparent impedance of line."  
Author.

**63. Methods of Drying and Storing of Secondary Battery Plates at Charged Conditions** (Japanese). **Sakae MAKIO**. [Researches, Electrot. Lab. Tokyo, Japan, **152** (1925), 1-12, with fig.]—The paper is a report on a preliminary experiment on the characteristics of secondary battery plates dried in carbon dioxide gas at charged conditions.  
M. H.

**64. Measurement of Impedance of Telephone Circuits** (Japanese). **Kazukiyo OGAWA**. [Researches, Electrot. Lab. Tokyo, Japan, **156** (1925), 1-12, with fig.]—The paper deals with the direct method of measuring the working impedance of telephone circuits by the alternating current bridge. After explaining the meaning of the working impedance of the telephone circuit, it is shown that the alternating current bridge must be so modified that the double balance of the bridge is required for measuring the above defined working impedance directly. The method is applicable to any kind of bridges. For a certain kind of bridge, however, if the telephone circuit

is assumed to be perfectly balanced against the earth, a single balance of the bridge is sufficient for measuring the working impedance. Author.

**65. Mercury Arrester** (Japanese). **Ryōtarō MITSUDA**. [Researches Electrot. Lab. Tokyo, Japan, **157** (1925), 1-54, with pl.]—The mercury lightning arrester is fully described with many service results in the field. The singular characteristics of this arrester are positively confirmed by the oscillographic test results and by the service results in the field. The essential features may be summarised as follows: 1. discharge voltage is made below 220 volts (a. c.) with quick and sure action; 2. the arrester is perfectly self-restoring and endures an exceedingly heavy discharge (above 150 amps.); 3. the gap is perfectly free from external disturbance such as insects, dust, moisture, etc.; 4. discharging arc voltage is very low (about 20 volts) and the discharge is very conspicuous; 5. protective capacity is much favoured by a heavy discharge current in consequence of the drooping characteristic of the mercury arc.

Six years experience of this arrester in the field is remarkably good and bespeaks the long endurance of the same. The protective capacity of the arrester under field tests is about 99.5% for the total number of about 8,000 cases of high voltage disturbances (used only for communication lines). Author.

**66. Rancidity of Oils and its Effects on the Telegraph Perforator Tape** (Japanese). **Wakasaburō OGAWA** and **Saikichi MIZUSHIMA**. [Researches, Electrot. Lab. Tokyo, Japan, **159** (1925), 1-25.]—The cause of deterioration of telegraph perforator tapes now in use in Japan was examined and is attributed to the rancidity of vegetable oils impregnated into the tape.

Neutral mineral oil is found to protect the paper tape from deterioration by heat or light and is recommended as a suitable impregnating medium. Authors.

**67. On the Performance of Rectifiers** (Japanese). **Jirō MATSUURA**. [Researches, Electrot. Lab. Tokyo, Japan, **160** (1925), 1-42, with pl.]—The author investigates mathematically and experimentally the wave forms of rectified current of mechanically vibrating and tungsten rectifiers under various load conditions. M. H.

**68. On the Life of Vacuum Tubes** (Japanese). **Shōichi SANO**. [Researches, Electrot. Lab. Tokyo, Japan, **161** (1925), 1-20, with fig.]—The life of a thermionic vacuum tube is discussed mathematically and empirically. The result of experiments made by the author since 1922 on the twenty-two 150-watt pilotrons are reported. M. H.

**69. On the Devitrification of Glasses, the First Report.** **Kōzō TABATA**, **Kensuke YEGAMI** and **Sizuta MORIYASU**. [Researches, Electrot. Lab. Tokyo, Japan, **162** (1925), 1-28, with pl.]—The paper is the report of the author's preliminary experiments on the devitrification of glasses. Samples were taken from depleted and newly manufactured radio transmitting and receiving bulbs whose previous histories were unknown. Results of chemical analysis on each glass are described. It is qualitatively shown that there are close relations between the chemical compositions and the mode of devitrification of glasses upon heating. Authors.



**70. Illumination due to a Polygonal Light Source of Uniform Brightness and a Rectilinear Light Source** (Japanese). **Yoshikazu OMOTO.**

[J. Ill. Eng. Soc. Japan, VIII., 4 (1924), 285-292, with fig.]—It is shown that the illumination at any point on a surface illuminated by a surface source of uniform brightness bounded by a polygon, which may not have all its sides in one plane, is given by

the following formula;  $E = \frac{b}{2} \sum \alpha \cos \beta$

where  $E$  denotes the illumination at any point  $P$  on the illuminated plane,  $b$  the brightness of the surface source,  $\sum$  the sum of similar terms for all the sides of the polygon,  $\alpha$  the angle subtended at  $P$  by a side of the polygon, and  $\beta$  the angle which the plane, containing the same side and the point  $P$ , makes with the illuminated plane, and is on that side of the former plane which is away from the surface source.

Then the rectilinear light source is treated as a limiting case, and the following formula is deduced;  $E = \frac{Q}{2l} \left[ \frac{1}{p} \cos \beta_1 + \frac{1}{q} \cos \beta_3 + \frac{x_2}{r} \sin \beta_2 \right]$

where  $E$  denotes the illumination at any point  $P$  on the illuminated plane,  $Q$  the candle-power of the rectilinear source in a direction perpendicular to itself,  $l$  the length of the rectilinear source,  $p$  and  $q$  the distances from  $P$  to the ends of the source,  $\beta_1$  and  $\beta_3$  the angles between the perpendicular to the illuminated plane from any point in the source, and the perpendiculars to the  $p$  and  $q$  lines from the same point,  $x_2$  the angle subtended at  $P$  by the source,  $\beta_2$  the angle between the illuminated plane and the plane containing the point  $P$  and the source, and  $r$  the length of the segment, between  $P$  and the source, of the straight line drawn through  $P$  on the plane containing the source and  $P$ , at right angles to the intersection of this and the illuminated planes.

Author.

**71. On Geometrical Calculation of Illumination for Surface Sources** (Japanese). **Zirō YAMANOUCHI.** [J. Ill. Eng. Soc. Japan, VIII., 4 (1924), 293-301, with fig.]—The present paper is the generalization of the problem dealt with in the

previous paper (J. Ill. Eng. Soc. Japan, VIII., 3) by the same author. The value of illumination produced by surface sources of any form is obtainable in any direction at any point in space.

M. H.

**72. On a New Method of Manufacturing a Large-sized Parabolic Mirror Answering the True Nature of It** (Japanese). **Fusazō MIZOJIRI.**

[J. Ill. Eng. Soc. Japan, VIII., 4 (1924), 317-363, with fig.]—The author discusses the nature of the curve of search-light mirrors, for the purpose of explaining whether it is necessary to attach importance only to the point of increasing optical efficiency or not, when observed from the point of view of the nature of the search-light mirror. As the result of this discussion, the author concludes that progress in the optical efficiency of the mirror will have little effect upon the luminous efficiency of search-lights. Then the author refers to the relation between the absorption of light by air and the wave-length of light and ascertains that, if the mirror surface be made such that it may have a special curve from the point of view of wave-length of light, it may be easy to make a variation in luminosity which can be discerned by the retina. He thus concludes that further progress will depend more on metallic mirrors than on glass ones. Lastly, the author proposes a new method, invented by him, of manufacturing a metallic search-light mirror that can illuminate long wave-length light.

M. H.

**73. The Electric "Kotatsu"** (Japanese). Matsujirō ŌYAMA. [J. Ill. Eng. Soc. Japan, IX., 1 (1925), 33-51, with fig.]—The "Kotatsu" is a heater used in bed. This paper describes the test results and some discussions about them. Author.

**74. A New Calculating Method of Light Flux, and a New Light Distribution Curve** (Japanese). Shigehiro SEKI. [J. Ill. Eng. Soc. Japan, IX., 3 (1925), 360-368, with fig.]—After discussing the features of the known methods of obtaining light flux from distribution curves, the author proposes a new method of his own design. The new method does not involve any degree of skill; moreover it may be readily used by unfamiliar hands with accuracy. The author also points out the error in Wohlaue's method in the value of the constant used, and corrects it. Then the author devises a particular type of distribution curve for studying street lighting fixtures. By means of this curve, not only the light distribution but also the illumination on the road may be deduced at the same time. M. H.

**75. Approximate Methods of Calculating the Mean Value and its Application to the Determination of Mean Candle-power and Total Flux, I** (Japanese). Zirō YAMANOUCI. [J. Ill. Eng. Soc. Japan, IX., 3 (1925), 369-390, with fig.]—The several methods of approximate calculation of mean value are shown. The number of ordinates taken are 2 to 10 and the coefficients are calculated to seven figures. The accuracy of these methods is compared by calculating the value of  $\int_0^1 x^m dx$  for  $2 \leq m \leq 10$ , and  $\frac{2}{\pi} \int_0^{\pi/2} \sin m\theta d\theta$  for  $m=1, 2, 3$  and 5. In appendices the roots of Legendre polynomials  $P_n=0$  are given to seven figures,  $n$  being 1 to 10. Author.

**76. Approximate Methods of Calculating the Mean Value and its Application to the Determination of Mean Candle-power and Total Flux, II** (Japanese). Zirō YAMANOUCI. [J. Ill. Eng. Soc. Japan, IX., 4 (1925), 411-432, with fig.]—The author proposes a new method of determining the mean hemispherical or spherical candle-power, or the total lumens, which he calls the "axial mean method." By this method, the intensities are measured in such directions that the mean hemispherical candle-power can be obtained by Gauss', Techebycheff's or other like methods along the lamp axis. Russell's or Macbeth's method is nothing but this rectangular axial mean method. Gauss' or Techebycheff's axial mean method gives a more accurate value than the rectangular one. The vertical angles at which observations are to be taken are shown when the number of observations does not exceed ten in the hemisphere. New simple approximate equations with two or three observations in each hemisphere to determine the mean hemispherical or spherical candle-power are proposed which may be a little more accurate than and as quickly solved as any of the existing simple equations with so many observations. Author.

**77. On the Intensity and the Lighting Cost of the Light emitted by Candles** (Japanese). Shigehiro SEKI. [J. Ill. Eng. Soc. Japan, IX., 4 (1925), 433-438, with fig.]—The author investigates the light given out by candles with respect to its intensity, light distribution, performance, spherical reduction factor, and lighting costs. The results show that an ordinary candle has an intensity from 0.5~1.2 c.p., which is

independent of its size; the spherical reductor is about 1.0; and the lighting cost is about one sen per candle-hour; that is about 30~100 times the electric lighting cost.

Author.

**78. *Economical Study of Overhead High Tension Distribution Lines*** (Japanese). **Yonejirō KAGAMI** and **Yasuji IWABUCHI**. [J. I. E. E. Japan, **437** (1924), 1155-1195, with fig.]

**79. *On the Diameter and the Lamination of the Rotary Electric Machine*** (Japanese). **Tadashi SEIKE**. [J. I. E. E. Japan, **438** (1925), 5-33, with fig.]

**80. *On the Time Lag Measurement of Spark*** (Japanese). **Matsunosuke IWATAKE**. [J. I. E. E. Japan, **438** (1925), 45-56, with fig.]

**81. *On the Synchronization of Triode Oscillators*** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **438** (1925), 57-76, with fig.]

**82. *On the Creepage over Solid Insulation in Air and in Oil*** (Japanese). **Shigeo MOCHIZUKI**. [J. I. E. E. Japan, **438** (1925), 83-89, with fig. and pl.]

**83. *On the Time Lag Measurements of Spark in Transformer Oil*** (Japanese). **Matsunosuke IWATAKE**. [J. I. E. E. Japan, **440** (1925), 217-226, with fig.]

**84. *Systematic Study on Self Capacity of Coils for Radio Use***. **Isamu YAMAMOTO**. [J. I. E. E. Japan, **440** (1925), 259-277, with fig.]

**85. *On the Tungar Rectifier*** (Japanese). **Hidetsugu YAGI** and **Ichijirō WATANABE**. [J. I. E. E. Japan, **441** (1925), 305-310, with fig.]

**86. *The Induction Type Protective Relay*** (Japanese). **Hidetsugu YAGI** and **Tomotaru KAMIYA**. [J. I. E. E. Japan, **441** (1925), 318-338, with fig.]

**87. *Grounding Reactor with D. C. Excited Iron Core*** (Japanese). **Masuho TERADA**. [J. I. E. E. Japan, **443** (1925), 497-489, with fig.]

**88. *On the Self-Excitation of Three-Phase Series Motors*** (Japanese). **Kenkichi INAGAWA**. [J. I. E. E. Japan, **443** (1925), 497-507, with fig.]

**89. *On the Creepage over Solid Insulators in Benzol, Paraffin Oil and Paraffin Wax*** (Japanese). **Shigeo MOCHIZUKI**. [J. I. E. E. Japan, **444** (1925), 630-634, with fig.]

**90. *On the Time Lag Measurement of Spark in Solid Dielectric*** (Japanese). **Matsunosuke IWATAKE**. [J. I. E. E. Japan, **446** (1925), 819-830, with fig.]

91. *Measurement of the Input Impedance of Triode Valves* (Japanese). **Shigeyoshi MATSUMAE**. [J. I. E. E. Japan, **447** (1925), 918-931, with fig.]

92. *On the Meaning of Extract-Method of Inspection in the Light of the Theory of Probability* (Japanese). **Rinkichi YONEDA**. [Researches, Electrot. Lab. Tokyo, Japan, **150** (1924), 1-18, with fig.]

93. *Free Oscillation of Transmission Lines and Propagation of Surge*. **Katsuji NAKANISHI**. [Researches, Electrot. Lab. Tokyo, Japan, **154** (1925), 1-39, with pl.]

94. *Power Measurement at High Voltage with a Low Tension Quadrant Electrometer* (Japanese). **Osamu NARAZAKI** and **Mokuji DOTE**. [Researches, Electrot. Lab. Tokyo, Japan, **158** (1925), 1-14, with fig.]

95. *Tungsten Arc Lamp as an Audio-frequency Oscillation Generator* (Japanese). **Shintarō UDA** and **Takeo SUGIMOTO**. [Denki-Hyōron, XIII., **3** (1925), 261-264, with fig.]

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## MINE ENGINEERING (I—II).

1. *The Nature of Coal Clinker and its Recovery* (Japanese). **Kichirō YAMAGUCHI**. [Nihon-Kōgyōkwaishi, Ser. XLI., 483 (1925), 499-518, with fig. and tables.]—A report of tests upon the magnetic property of coal clinker, its washability and flotability for its recovery. H. S.

2. *Effects of Temperature and Pressure on the Explosibility of Coal-Dust and Air Mixtures* (Japanese). **Hidenosuke SANO**. [Nihon-Kōgyōkwaishi, Ser. XLI., 486 (1925), 845-852, with fig. and tables.]—It has been shown that the lower limit of inflammation in coal-dust and air mixtures descends with rising initial temperature. Increasing the initial pressure of the mixture up to 5 atmospheres from atmospheric pressure had no effect in changing its lower limit, but had the tendency to lower its ignition temperature. Dust clouds which are incapable of starting inflammation by simple ignition can propagate explosions, being affected by rising initial temperature and pressure caused by the pioneering wave accompanied ahead by the flame of explosion. Author.

3. *Some Studies on the Nature of Coal Particles with special reference to its Dressing* (Japanese). **Takeshi TAKAKUWA**. [Nihon-Kōgyōkwaishi, Ser. XLI., 486 (1925), 853-880, with fig. and tables.]—A survey of the nature of coal particles by screen analysis and float-sink tests. H. S.

4. *Tests of Air Rock-Drills* (Japanese). **Hidenosuke SANO** and **Hidesaburō AOYAMA**. [Nihon-Kōgyōkwaishi, Ser. XLI., 487 (1925), 935-970, with fig. and tables.]—A report of tests on rock drills by Paynter's tester. The number of strikes of bits is found to be rather directly proportional to air pressure than in accordance with Weston's formula. Authors.

5. *Measurement of the Value of the Birefringence of Minerals in Thin Sections* (Japanese). **Shigeru NISHIO**. [Nihon-Kōgyōkwaishi, Ser. XLI., 488 (1925), 1049-1069, with fig. and tables.]—Determination of the diagonal birefringence is proposed. H. S.

6. *Drill Steel and Drill Bits* (Japanese). **Shinpachi MIYOSHI**. [The Suiyō-Kwaishi, IV., 8-9 (1925), 1173-1194, and 1247-1265, with fig., phot. and tables.]—Heat treatment of rock-drill steel and good shapes of drill bits are investigated by boring tests in several kinds of rocks. H. S.

7. *Magnetic Separation of Pyrrhotite from Chalcopyrite* (Japanese). **Jūrō SHIMONO**. [The Suiyō-Kwaishi, IV., 9 (1925), 1267-1288, with fig. and tables.]—Separation of pyrrhotite from chalcopyrite on sphalerite by means of the electro-magnetic table without preliminary roasting is investigated. H. S.

8. *Shapes of Hatches of Coal-Jigs* (Japanese). **Yōichi OKADA** and **Yutaka YAMADA**. [Monthly Rep. C. C. M. A. Japan, XXI, 247 (1925), 12-16, with fig. and a table.]—Some characteristic motions of water in sieve compartments of jigs, affected by the different shapes of hatches, are investigated in connection with the efficiency of yielding. The round shape is recognized to be the most efficient.

H. S.

9. *Natural Ventilation in Mines* (Japanese). **Fumio ODA**. [Monthly Rep. C. C. M. A. Japan, XXI, 254 (1925), 731-753, with fig. and tables.]—Determination of the equivalent orifice of a mine in connection with effects of its natural ventilation is discussed.

H. S.

10. *Sinkings in Ube Coal Field, Yamaguchi Prefecture, Japan* (Japanese). **Fujie KANENO**. [Kyūshū-Kōzangakkwaishi, I, 7 (1925), 591-610, with fig., a map and tables.]—This paper describes sinking of shafts in Ube coal field, which were sunk in the sea by means of a special drop-shaft method.

H. S.

11. *On Sintering of Iron Concentrates* (Japanese). **Gaichi YAMADA**. [The Suiyō-Kwaishi, IV, 10 (1925), 1409-1424, with fig. and tables.]

## METALLURGY (1—66).

1. *On Reduction of Iron Ore* (Japanese). **Heihachi KAMURA**. [Tetsu-to-Hagane, XI., 1 (1925), 11-30, with diag., fig. and tables.]—It is shown that all iron ores can be completely converted to a metallic state at 950°C. or 900°C. by carbon-monoxide. The proper size of the ore is about 1 inch or so; the ore which is smaller than 1 inch can be reduced in 3 or 4 hours at these temperatures. When ores of smaller size are used, the quantity of heat required for the reduction is much less. If the efficiency of the heat of the blast furnace be 40% by this low-temperature reduction, iron can be directly obtained from ore with 60% of the heat quantity for ordinary furnace smelting.

H. G.

2. *On the Relation of Dimensions and Elongation of Test Pieces, Part V, Effect of the Length in Parallel Parts* (Japanese). **Kajima MUROI**. [Tetsu-to-Hagane, XI., 1 (1925), 31-43, with diag. and tables.]—In tensile testing the elongation is increased with the length of the parallel parts even if the section and the gauge length of the test pieces are constant. But the rate of increase of elongation is decreased with the increase of the length of the parallel parts.

The effect of the length of the parallel parts on the elongation is larger with malleable materials. With specimens of round bars, the effect of the length of parallel parts to elongation is marked only for those materials which have more than 30% ultimate elongation.

H. G.

3. *Investigation of Casting Sand* (Japanese). **Tario KIKUTA**. [Tetsu-to-Hagane, XI., 2 (1925), 79-116, with diag., fig. and tables.]—Various kinds of casting sands were subjected to ventilation tests, and the effect of clay and moisture were investigated. Tests of viscosity were also made.

H. G.

4. *On a New Process of Making Thin Iron Plate by Electrolysis* (Japanese). **Shirōji HATTA**. [Tetsu-to-Hagane, XI., 3 (1925), 155-169, with diag., fig. and tables.]—By an electrolytic method in which iron is deposited on a revolving pole having an intermediate potential between a cathode and an anode, electrolytic iron which contains no hydrogen can be produced. This iron is soft and tough, and can be taken off easily from the pole even when it is very thin. The temperature of the electrolyte which must have a certain acidity should be above 70°C. The iron obtained by this method shows the genuine properties of pure iron when annealed, and when it is heat-treated the magnetic property is just the same as that of pure iron.

H. G.

5. *On Acid-proof Iron Alloys* (Japanese). **Kurazō FUKAGAWA**. [Tetsu-to-Hagane, XI., 3 (1925), 169-194, with diag., phot. and tables.]—It was found that the increase of elements which did not make solid solutions increased the degree of corrosion.

H. G.

6. *Theoretical Investigation of the Construction and Operation of Cupolas* (Japanese). **Masaya HIRAOKA**. [Tetsu-to-Hagane, XI., 4 (1925), 239-283, with diag., fig. and tables.]—A formula giving the point of the highest temperature in

a enpola in relation to the furnace height, blast-pressure and the ratio of tuyeres is found. The penetration length of blast in terms of the diameter of the furnace, blast-pressure, ratio of tuyeres and furnace height is also given. H. G.

**7. On the Annealing of Steel** (Japanese). **Shōzō SAITŌ**. [Tetsu-to-Hagane, XI, 4 (1925), 283-300, with diag., phot. and tables.]—The annealing tests were made with steel which contained 0.34% and 0.53% C at temperatures of 800°C. and 1,200°C. After annealing the steel was subjected to tensile tests, hardness and Sharpee's shock tests. Two kinds of changes were found to occur in annealing, the one being the diffusion of impurities, the other the enlargement of crystals. It was inferred therefrom that the annealing of steel should be made in two steps, once at a higher temperature and then at a lower temperature. H. G.

**8. On Sintering of Sulphate-sinder** (Japanese). **Ichirō ŌHIRA**. [Tetsu-to-Hagane, XI, 6 (1925), 421-436, with diag., fig., phot. and tables.]—When the sinder was roasted in air, resistivity to pressure suddenly increased at and above 1,000°C. (its resistivity was 60 kg/cm<sup>2</sup>). In coal gas its value declined to 150 kg/cm<sup>2</sup> at 900°C. The breaking strength by shock was proportional to the resistivity to pressure. Its porosity quickly decreased at and above 900°C. The ferrous state in the original ore was lost by 96% at 1,000°C. in 30 min.; and in coal gas some metallic iron was recognized at and above 1,000°C. Sulphur in the sinder was reduced by 94% in 30 min. and by 98% in 3 hours, keeping the temperature at 1,000°C. H. G.

**9. Investigation of Special Hard Aluminium Alloys and Theory of Tempering Hardening of Aluminium Alloys** (Japanese). **Tomojiro TANABE**. [Tetsu-to-Hagane, XI, 6 (1925), 437-457, with diag. and tables.]—The special hard Al-alloy contained 5% Mn and 0.5~2.0% Si. A good alloy was obtained by rolling after aging at ordinary temperature or by tempering at 200°C., in both cases the alloy having been quenched at 500°C. or 600°C. The quenching might be done by air-cooling. To explain the temper hardening a systematic research was made with Al-Cu and Al-Mg alloys, and some new facts were found from curves showing electric-resistance and heat-expansion. It was concluded that the temper hardening might be explained by the colloidal chemical theory. H. G.

**10. On the Design of Blast Furnace of the Kenjiho Iron Works** (Japanese). **Takeshi KAWAMURA**. [Tetsu-to-Hagane, XI, 8 (1925), 535-570, with diag., fig. and tables.]—The efficiency of the blast furnace is increased by increasing the amount and the pressure of the blast, with a large diameter of the hearth and with a sharp and low bosh. These conditions are especially important for making basic iron.

With a charge consisting for the greater part of limonite as in the case of the Kenjiho Iron Smelter, the angle of the shaft must be obtuse to prevent the upper hanging in the upper part of the furnace.

The furnace of the Kenjiho Smelter has no auxiliary tuyeres; the formation of salamander in the upper as well as in the lower part of the furnace may be prevented by making improvements in the inside profile of the furnace. H. G.



11. *On Heat Conductivity of Iron and Steel* (Japanese). **Hitoshi MARUYE**. [Tetsu-to-Hagane, XI, 8 (1925), 571-575, with fig. and tables.]—With regard to pig iron, grey pig which is inbedded with non-conductive graphite has better conductivity than white pig; this fact depends upon the difference of the conductivity of cementite and the ground metal. Carbon and copper in steel increase its conductivity to a certain extent, and nickel, chromium, silicon and manganese always lessen it. As to the constituents of carbon steel, pearlite is the most conductive, sorbite comes next, while martensite and austenite are the worst. H. G.

12. *On Investigation of Treatment of Fine Ore* (Japanese). **Yoshihiko HIRAKAWA**. [Tetsu-to-Hagane, XI, 10 (1925), 689-695, with fig. and tables.]—The difficulty of operation due to "hanging" in a furnace can be entirely removed by concentrating heat in a special position near the furnace mouth. This process may be an improvement for roasting. By increasing the length of the furnace to about twice that of the ordinary ones and keeping the amount of furnace gas constant, by using a hot blast instead of a cold one, and by regulating the amount of blast freely, it may be expected that twice the present production can be obtained. H. G.

13. *On Fine Grain Spots in the Fracture of Pig Iron* (Japanese). **Kamezō TAGUMA**. [Tetsu-to-Hagane, XI, 10 (1925), 697-709, with fig., phot. and tables.]—Two kinds of spots, surface-spots and inner-spots, were distinguished. The surface-spots show themselves inferior ingots and the inner-spots exist mainly in pig iron of inferior quality. These inner-spots are produced by the segregation of eutectic. In practice these inner-spots exercised a great effect on casting. H. G.

14. *On Permanent Stress of Casting and Process of its Removal in Ingot Casting* (Japanese). **Tokiji ISHIKAWA**. [Tetsu-to-Hagane, XI, 11 (1925), 735-755, with diag., fig. and tables.]—The internal stress of ingot casting can be removed by annealing at a comparatively low temperature, say 200°C. To remove the internal stress completely, the annealing should be done for 6 or 10 hours at 550° or 600°C, and the cooling requires more than 2 days. The annealing temperature of the ordinary ingot casting may be the same for all its chemical compositions. The deformation of ingot casting due to annealing is proportional to the amount of removal of internal stress. H. G.

15. *On Quantitative Analysis of Sulphur in Iron and Steel* (Japanese). **Kumahiko HASEGAWA, Sukenori ISHIGA and Tōru NAITO**. [Tetsu-to-Hagane, XI, 12 (1925), 831-873, with fig. and tables.]—For common steel correct results can be obtained by the reduction process, the oxidation process being unnecessary. For special steels, however, the ordinary reduction process is not suitable; they should be annealed and then it should be applied. For pig iron either of the processes is equally applicable. H. G.

16. *On Influence of Molybdenum on Property of Steel* (Japanese). **Hareto KIKKAWA**. [Tetsu-to-Hagane, XI, 12 (1925), 874-890, with diag., phot. and tables.]—Molybdenum in steel lessens segregation and the sulphur content, and increases

its elastic limit and resistivity against shock. By adding molybdenum, steel attains a uniform quality without showing any brittleness in tempering, but the result of repeated bending tests is not improved thereby.

H. G.

**17. On Various Kinds of Aluminium Alloys** (Japanese). **Masaji GOTÔ** and **Tokushichi MISHIMA**. [Nihon-Kôgyôkwaishi, Ser. XLI., 477 (1925), 1-17, with diag. and tables.]—Molton Al-Mn alloy separates into two layers in the range from 90% to 55% of Al and also 5% to 10% of Al; this is contrary to Hindrie's view. Compounds such as  $\text{Al}_2\text{Mn}$ ,  $\text{AlMn}_3$  and  $\text{Al}_5\text{Mn}$  were observed in this alloy. In investigating various ternary alloys such as the Al-Cu-Fe, Al-Si-Cu, Al-Si-Ag and Al-Cu-Ag systems, their solidifying temperatures were measured and diagrams of their composition and temperatures were obtained. In the Al-Cu-Ni system the authors did not recognize the line at 55°C. which was observed by Gwyer.

H. G.

**18. On the Smelting of Zinc** (Japanese). **Kiyoshi ODA**. [Nihon-Kôgyôkwaishi, Ser. XLI., 477 (1925), 18-36, with tables.]—The development on the smelting processes of zinc and its production are described. The various present methods of zinc smelting, the present and future conditions of the zinc industry in Japan, and the reserves of zinc ore in the world are also discussed and mentioned.

H. G.

**19. On Mechanical Properties of 7-3 and 6-4 Brasses at High Temperature** (Japanese). **Hiroshi IMAI**. [Nihon-Kôgyôkwaishi, Ser. XLI., 480 (1925), 216-239, with diag., fig., phot. and tables.]—Tensile tests of alloys were made and therefrom hardness, elongation and shrinkage at high temperature were diagrammatically analysed, from which several maximum and minimum points and other particular points were observed. The proper temperature for rolling was found to be between 710° and 690°C. for the 7-3 brass, and between 700°-800°C. for the 6-4 brass. With the 7-3 brass at 200°C. and with the 6-4 brass at 150°C. the elongation and shrinkage in area were greatly reduced. Other important properties are also described.

H. G.

**20. On Alloys of Lead, Cadmium and Tin** (Japanese). **Kyôsuke KANEKO** and **Akira ARAKI**. [Nihon-Kôgyôkwaishi, Ser. XLI., 482 (1925), 437-455, with diag., phot. and tables.]—The eutectic temperature of this alloy was determined at the eutectic point, which is at 6.28% tin. At the eutectic temperature very faint unstable changes were observed at 162° and 148°C., but it seemed that such transformation did not occur in alloys which were annealed completely. These alloys are stable in the following cases:—

Tin-side, up to 1% Pb, when they are of solid solution, and in the lead-side, up to 18% by 181°C., and up to 15% in cold state. A Pb-Sn compound was observed at 36.3% tin. The hardness changes greatly at about 36.3% and 99% Sn. Regarding their solubility to 1/10 normal solution of HCl, pure lead has a minimum solubility gradually increasing up to 18% Sn, and thence remains nearly constant up to pure tin. The solubility to conc. HCl is nearly uniform in the range from pure Pb to 20% Sn, and gradually increases up to 50% Sn, then again becomes constant up to pure tin.

H. G.

**21. On Electrolysis of Tin at the Mitsubishi Ōsaka Refinery** (Japanese). **Zenshichi KIMURA**. [Nihon-Kōgyōkwaishi, Ser. XLI., **484** (1925), 602-638, with tables.]—Crude tin metal obtained from ores of the Akenobe mine is refined by electrolysis. Hydrofluosilicic acid has been used as the electrolyte since 1920. Various kinds of electrolytes were compared with each other, varying the quality of anode, acidity of electrolyte, current density, and working time. Experiments were made on the reduction-degree of tin in solution, purity of cathode, amount of slime and condition of deposition.

In practice, the electrolyte contains 8-10%  $\text{Si F}_6 \text{H}_2$ , 2.5-3%  $\text{Si F}_6 \text{Sn}_2$ , 2%  $\text{H}_2 \text{SO}_4$ , a small amount of  $\text{F}_4 \text{Si}$  and  $\beta\text{-C}_{10}\text{H}_7(\text{OH})$ , and 0.3% glue. Current density is 83.3-41.6 amp./sq. m. of anode area, voltage being 0.33 or 0.15 volt at 15-28°C. The current efficiency is 85-75% and loss of  $\text{Si F}_4$  amounts to 8 kg. per ton of electrolytic tin. In this plant 60 tons of tin are treated monthly at present. H. G.

**22. Investigation on Roasting of Pyrites by Heat Balance** (Japanese). **Heikichi SAITŌ**. [Nihon-Kōgyōkwaishi, Ser. XLI., **485** (1925), 726-759, with diag., fig. and tables.]—Various phenomena which occur at different roasting temperatures were observed by a continuously measuring method, for the purpose of studying its characteristic change under various conditions. Gas produced while roasting was examined by the continuous method to study its change in parallel with that of the ore. In addition to the investigation in a closed vessel various characteristic changes occurring while roasting at different temperatures were detected by the method of heat balance. H. G.

**23. On Metallic Bacteria** (Japanese). **Chikahira TONAMI**. [Nihon-Kōgyōkwaishi, Ser. XLI., **487** (1925), 981-985, with phot.]—All kinds of metallic bacteria are enumerated and their properties explained. Iron in water containing some free carbonic acid will be converted to ferrous carbonate, which is absorbed by bacteria and ferrous hydroxide is deposited after its assimilating process; this is a cause of the production of iron rust. Bacteria may become a catalyser for the corrosion of iron. The corrosion of aluminium in water may also happen in the same manner. H. G.

**24. On the Extraction of Copper by Ramen's Process** (Japanese). **Jintarō KOJIMA**. [Nihon-Kōgyōkwaishi, Ser. XLI., **488** (1925), 1027-1042, with fig.]—The history, the chemical reactions, the design protected by patent and the operating plan of the Ramen's process are explained in detail, and the practical data at the Ōsaka Smelting Co., are given.

The ores treated by this process are transported from the Kune and Iimori mines, their composition being Cu, 3.81; Fe, 54.23; S, 5.08;  $\text{SiO}_2$ , 10.02; etc. By roasting on the addition of salt, 91.5 per cent. of copper becomes soluble in water. The cement copper contains 71.3 per cent. of Cu; 4.35 per cent. of Fe and is refined to 99.84 per cent. of Cu by a reverberatory furnace.

The purple ore contains 52.90 per cent. of Fe; 9.52 per cent. of  $\text{SiO}_2$ ; 0.928 per cent. of S and 0.12 per cent. of Cu.

The consumption of salt in this process amount to 13 or 17 per cent. The cost of extraction is ¥7.79 per ton of ore including all expenses. In conclusion, the Ramen's

process and the dry extraction process are compared, giving their detailed advantages and disadvantages. H. G.

**25. On Graphitization of White Pig Iron, Part IV** (Japanese). **Hiroshi SAWAMURA**. [The Suiyô-Kwaishi, IV., 8 (1925), 1195-1220, with diag., phot. and tables.]—It is described how copper, nickel and cobalt promote the graphitization of white pig iron. H. G.

**26. On Influence of Aluminium on White Metal of Lead Base** (Japanese). **Yoshio FUKUTANI**. [The Suiyô-Kwaishi, IV., 9 (1925), 1239-1299, with diag., phot. and tables.]—By adding aluminium to white metal of lead base, the hardness was increased, blow holes were removed, compound of Sb-Sn became distributed uniformly, the compressive strength and toughness were increased, and the friction loss was reduced. These facts showed that white metal containing aluminium is a proper material for use as a bearing metal. H. G.

**27. On Influence of Metallic Impurities on Aluminium, Part II** (Japanese). **Takayasu HARADA**. [The Suiyô Kwaishi, IV., 9 (1925), 1301-1354, with diag., fig. and tables.]—The elongation of aluminium containing nickel was increased considerably by annealing. The hardness of aluminium was increased by Mg, Mn and Cu. A maximum strength was found in a system of duralumin. The electric conductivity was seriously injured by Mg and Mn. A quaternary alloy of Al-Cu-Ni-Fe has an inferior electric conductivity and a strong hardness. H. G.

**28. On Graphitization of White Pig Iron, Part V** (Japanese). **Hiroshi SAWAMURA**. [The Suiyô-Kwaishi, IV., 9 (1925), 1355-1372, with diag., phot. and tables.]—Titanium promotes the graphitization of white pig, but it is not so effective as silicon. Chromium, tungsten, vanadium and molybdenum prevent the graphitization of white pig. Platinum and gold were shown to promote it. H. G.

**29. On Production of Low Carbon Chromium Steel** (Japanese). **Tetsuyuki FUJIMURA**. [The Suiyô-Kwaishi, IV., 10 (1925), 1425-1439, with tables.]—Decarbonization by chromium ore and Mn-dioxide was very incomplete; a comparatively good result was obtained by adding ferro-silicon or silicon and Cr-ore or Mn. H. G.

**30. Investigation of an Alloy System of Al-Sn-Zn** (Japanese). **Hideo NISHIMURA** and **Ôsuke SUZUKI**. [The Suiyô-Kwaishi, IV., 10 (1925), 1441-1453, with diag., phot. and tables.]—The constitutional diagram of this alloy system is explained both theoretically and practically, and the constant point was discovered as  $L + \beta \rightarrow \alpha + \gamma$ . It was found that the ternary eutectic point of  $L \rightarrow \alpha + \gamma + \delta$  coincided at the eutectic point of the binary alloy of Sn and Zn. H. G.

**31. On Manufacturing Ingots** (Japanese). **Genji ÔISHI**. [Seitetsu-Kenkyûkai-Kiji, 84 (1925), 1-20, with diag. and fig.]—Necessary precautions for the degree of killing, the oxidation after tapping, teeming, the regulation of cooling speed, the composition of molten steel, moulding and others are mentioned; also detailed



descriptions are given with regard to the order of solidifying of molten steel, volume change during cooling, columnar crystals on crust and forms of moulds, blow holes, pipes, segregation, etc. H. G.

**32. On Steel Casting and its Moulds** (Japanese). **Mitsuhira TANIGUCHI**. [Seitetsu-Kenkyūkai-Kiji, **84** (1925), 21-45, with diag., fig. and tables.]—Methods of manufacturing steel ingots and moulds for casting steel, together with the properties thereof, are described for steel ingots produced from the open hearth. H. G.

**33. On Carbon Steel and its Hardness** (Japanese). **Zennosuke MIMURA**. [Seitetsu-Kenkyūkai-Kiji, **84** (1925), 45-47, with diag. and tables.]—The hardness of test pieces after heat treatment was measured by Brinell's hardness testing machine of 10 mm. ball and 3,000 kg. weight. Up to 0.3% C the rate of increase of hardness is comparatively small, but about this point the hardness suddenly increases, being especially remarkable in case of water quenched steel. Near 0.7% C the hardness reaches a maximum, and above 1% C it has a tendency to decrease. H. G.

**34. On Calculation of Burning Temperature of Producer Gas** (Japanese). **Yoshiaki TADOKORO** and **Tōru KAWACHI**. [Seitetsu-Kenkyūkai-Kiji, **15** (1925), 53-59, with tables.]—In the case of complete combustion of producer gas in air, formulae for estimating the heat quantity of hot gas, the amount of air necessary for combustion, the amount of combustible gas, the heat quantity in preheated air, the heat quantity necessary to heat combustible gas, the temperature of combustible gas etc., are given. The formulae relate to the gas produced by Kelpelly's gas producers in the Yawata Steel Works, its composition being CO, 25.65%; H<sub>2</sub>, 10.18%; CH<sub>4</sub>, 4.15%; O<sub>2</sub>, 0.23%; CO<sub>2</sub>, 4.06%; and N, 55.73%. H. G.

**35. On the Influence of Cooling Speed on the Growth of Casting by Repeated Heating** (Japanese). **Hidezō SAKURAI**. [Seitetsu-Kenkyūkai-Kiji, **85** (1925), 59-67, with fig., phot. and tables.]—During the casting period the slower the cooling speed was the more the growth was produced. The growth was observed with chilled castings, and was found to be of more than negligible amount. The hardness of the chilled casting considerably decreased by repeated heating. H. G.

**36. On the Tuyere** (Japanese). **Junichi KOMIYA**. [Seitetsu-Kenkyūkai-Kiji, **85** (1925), 67-77.]—Various forms of furnace-tuyeres, which have been adopted at the Yawata Steel Works, are mentioned, together with the composition of the tuyere-materials, etc. H. G.

**37. On Pearlite Casting** (Japanese). **Hidezō SAKURAI**. [Seitetsu-Kenkyū, **86** (1925), 129-133, with tables.]—Tests on pearlite casting from a practical point of view were made and the results are given. H. G.

**38. On Comparison of the Old and New Standard Rules with respect to the Elongation of Steel Bars** (Japanese). **Nobuo MOTOMORI**. [Seitetsu-Kenkyū, **86** (1925), 134-142, with diag. and tables.]—Various factors influencing the result of tensile testing, namely the relation of diameters to the gauge length, etc., were investigated for the purpose of comparing old and new Rules. H. G.

**39. On some Considerations regarding Drying Furnaces for Ingot Moulds** (Japanese). **Hidezō SAKURAI**. [Seitetsu-Kenkyū, **86** (1925), 143-148, with diag., fig. and tables.]—This paper describes how the fire-grate and the chimney of a drying furnace were reconstructed, the former being transformed into a part of the hearth, without decreasing its effective area, by adding two steel shelves on both sides of the furnace, the latter being reduced in sectional area. With the reconstructed furnace about 52% of coke was saved, without any leakage of smoke from the doors.

H. G.

**40. Some Considerations regarding Chilled Rolls** (Japanese). **Mitsuhira TANIGUCHI**. [Seitetsu-Kenkyū, **88** (1925), 209-222, with diag., fig. and phot.]—The crystals of chilled iron are considerably smaller than those of ordinary white pig. The forms and appearance of cementite in the chilled iron differ from those of pig iron, pearlite in white pig being mostly changed to sorbite when chilled. These facts were ascertained by comparing the chilled iron formed by rapid cooling and white pig obtained by slow cooling. The temperature of rolling should not be over 500°C., this being ascertained by tensile testings in a hot state.

It was also ascertained that needle-point-like cracks on the surface of chilled rolls occurred during rolling through insufficient chilling.

H. G.

**41. On Transformation Heat of Nickel and Cobalt** (Japanese). **Saburō UMINO**. [Seitetsu-Kenkyū, **89** (1925), 290-301, with diag. and tables.]—The heat content of strong magnetic substances, such as Ni and Co, was measured above and below their transformation points. It is explained that the transformations of Ni at 380°C., and Co at 460° and 1,150° C., depend only upon temperature. For the change from hexagonal close-packed to face-centered cubic one gr. of Co required about 1.185 cal., viz.  $1.16 \times 10^{-22}$  cal. for one molecule of Co. The magnetic transformation of Ni and Co required respectively about 2.01 and 2.195 cal. per gr., or  $1.95 \times 10^{-22}$  and  $2.14 \times 10^{-22}$  cal. per molecule.

If the transformation points be taken at the highest specific heat, which is obtained from the relation of the temperatures of these metals and their heat content, they are 380°C. for Ni and 459°C. and 1,150°C. for Co respectively.

H. G.

**42. On the Annealing Temperature of High Speed Steel** (Japanese). **Hideo URANO**. [J. Soc. Mech. Eng. Tokyo, XXVIII., **101** (1925), 717-764, with fig. and tables.]—The efficiency of machining in the workshop depends largely upon the heat-treatment of the tool steel. This fact was first found out by the late Mr. F. W. Taylor and has been generally acknowledged.

But it is the belief of the author that the true meaning of the tempering of high speed steel as a cutting tool has not been made clear. The tempering of high speed steel is discussed in this paper, in comparison with that of carbon tool steel. The tempering of the former not only gives toughness to the steel, but increases the cutting efficiency of the tools, while it seems that there is a certain range of temperature within which the best results are obtained.

From experiments the author learned that the physical properties of this steel after tempering are much affected by different kinds of quenching mediums, although all give practically the same hardness.

He gives an explanation of the meaning of the secondary hardness of high speed steel, but that of red hardness is left for future investigation.

In conclusion, he suggests the best tempering temperatures according to the nature of the cutting tool, and that the criterion by which to judge the quality of high speed steel is the degree of secondary hardness. Author.

**43. *On the New Light Aluminium Alloys C6 and MC* (Japanese). Tomojirō TANABE.** [J. Soc. Mech. Eng. Tokyo, XXVIII., 102 (1925), 820-835, with fig. and tables.]—The author prepared two new series of strong light aluminium alloys by special heat and mechanical treatment. One of them, called C6 alloy, contains 6% copper and 44% aluminium. The other, called MC, contains 1-2% copper, 0.5-1% magnesium, and aluminium balance. The author claims for the new alloys mechanical qualities that are not inferior, but rather superior, to those of duralumin K. K.

**44. *On Centrifugal Casting* (Japanese). Masatoshi ŌKŌCHI and Keikichi EBIHARA.** [Bull. Inst. Phy. Chem. Research, Tōkyō, IV., 6 (1925), 709-714, with fig., pl. and tables.]—Some kinds of castings, such as spur wheels and bells, are cast in rotating metallic moulds turning at 800-850 R.P.M., the material being aluminium, cast iron and bronze.

In the strength tests the centrifugally cast materials show very satisfactory results compared with the ordinary chilled and sand mould castings. Authors.

**45. *On Galvanizing Thin Steel Plates* (Japanese). Kenjirō SATŌ.** [Tetsu-to-Hagane, XI., 5 (1925), 329-356, with diag., fig. and tables.]

**46. *On Treating Poor Iron Ore Produced from the Anzan Iron Mine* (Japanese). Tsunesaburō UMENE.** [Tetsu-to-Hagane, XI., 6 (1925), 393-421, with diag., fig. and tables.]

**47. *On Plate Manufacturing in the Imperial Steel Works* (Japanese). Harutaka OHARA.** [Tetsu-to-Hagane, XI., 9 (1925), 605-626, with tables.]

**48. *On Determination of Oxygen in Iron and Steel* (Japanese). Hideo YOSHIZAWA.** [Tetsu-to-Hagane, XI., 9 (1925), 627-648, with diag., fig. and tables.]

**49. *On Aluminium Plating on Iron and Steel Materials* (Japanese). Keijirō SATŌ.** [Tetsu-to-Hagane, XI., 9 (1925), 649-655, with fig. and phot.]

**50. *On Hardening Theory of Metals* (Japanese). Kōtarō HONDA.** [Tetsu-to-Hagane, XI., 11 (1925), 726-734, with diag. and fig.]

**51. *On Deoxidation and Desulphurization in Steel-making* (Japanese). Genji ŌISHI.** [Tetsu-to-Hagane, XI., 11 (1925), 757-773, with phot. and tables.]

**52. On Investigation of Coal necessary for the Open Hearth Process** (Japanese). **Benzō FUKADA**. [Tetsu-to-Hagane, XI, II (1925), 775-808, with diag., fig. and tables.]

**53. On Construction of Copper Blast Furnaces** (Japanese). **Iwatarō TAKAHASHI**. [Nihon-Kōgyōkwaishi, Ser. XLI, 478 (1925), 87-103, with fig. and tables.]

**54. On Peritectoid Transformation** (Japanese). **Hideo NISHIMURA**. [The Suiyō-Kwaishi, IV., 8 (1925), 1221-1223, with diag.]

**55. On Peritectoid** (Japanese). **Hideo NISHIMURA**. [The Suiyō-Kwaishi, IV., 9 (1925), 1373-1375, with diag.]

**56. On Influence of Metallic Impurities on Aluminium** (Japanese). **Takayasu HARADA**. [The Suiyō-Kwaishi, IV., 10 (1925), 1400-1408, with diag., fig. and tables.]

**57. On the Influence of Nickel on Alloys of Al-Si, Part I** (Japanese). **Chyūyo HISATSUNE**. [The Suiyō-Kwaishi, IV., 10 (1925), 1455-1461, with diag., phot. and tables.]

**58. On the Influence of Chemical Composition on Cast Iron** (Japanese). **Mitsuhira TANIGUCHI**. [Seitetsu-Kenkyūkai-Kiji, 85 (1925), 84-111, with fig. and tables.]

**59. On the Influence of Manganese on Steel from the Basic Open Hearth** (Japanese). **Isamu KōRA**. [Seitetsu-Kenkyū, 86 (1925), 117-123, with diag. and fig.]

**60. On Causes of False Casting with Cast Iron and Gun-metal** (Japanese). **Hidezō SAKURAI**. [Seitetsu-Kenkyū, 86 (1925), 153-157, with tables.]

**61. A Study of Centrifugal Casting** (Japanese). **Mitsuji ARAKI**. [Bull. Military Arsenal, III, I (1925), 25-33, with fig. and tables.]

**62. On the Sand Mould Castings of Aluminium-Manganese Brass** (Japanese). **Takeo MUKAI**. [Bull. Military Arsenal, III, I (1925), 39-48, with fig. and tables.]

**63. On the Relation between the Strength and Structure of Cast Iron** (Japanese). **Kazuma YURI**. [Bull. Military Arsenal, III, 3 (1925), 118-122, with fig. and pl.]



64. *Experimental Study of the Corrosion of Aluminium Table-Wares* (Japanese). **Shinjiro NAKATSUKASA**. [Bull. Military Arsenal, III., 4 (1925), 251-263, with phot.]

65. *"Woody Fracture" of Steel Forgings* (Japanese). **Nobutake TAMURA**. [Bull. Military Arsenal, III., 5 (1925), 293-307, with fig. and tables.]

66. *Utilization of Waste Sulphite Liquid from Paper-Mills and Investigation of Moulding Sand for Steel Castings* (Japanese). **Nobutake TAMURA** and **Teigorō NAKANO**. [Bull. Military Arsenal, III., 8 (1925), 533-593, with fig. and tables.]



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## CIVIL ENGINEERING (1—42).

**1. Remarks on River Problems** (Japanese). **Hidesaburō NAKAYAMA.** [J. Civ. Eng. Soc., XI., 1 (1925), 1-12.]—This is a presidential address given by the author at the annual meeting of the Civ. Eng. Soc. on January 17, 1925. K. Y.

**2. Straight Beams under Bending and Torsional Moments.** **Yōsei YAMADA.** [J. Civ. Eng. Soc., XI., 3 (1925), 497-522, with fig.]—This paper gives the deflection, the rotation, and the elongation of the neutral axis of a straight beam subjected to bending and torsion.

They are approximately given by the well-known formulae:—

$$EI \frac{d^2 z}{dx^2} = M, \quad EI' \frac{d^2 y}{dx^2} = B, \quad \mu J \frac{d\varphi}{dx} = T, \quad EF \frac{dJs}{dx} = N$$

where

$M$ =Bending moment about  $y$ -axis,  
 $B$ =Bending moment about  $z$ -axis,  
 $T$ =Torsional moment,  
 $N$ =Direct load,  
 $z$ =Amount of deflection parallel to  $z$ -axis,  
 $y$ =Amount of deflection parallel to  $y$ -axis,  
 $\varphi$ =Angle of rotation  
 $Js$ =Elongation.

The author proposes that  $M', B', T'$  and  $N'$ , as given below, should be used instead of  $M, B, T$ , and  $N$  in the above formulae, because the beam is no longer straight when subjected to moments.

$$M' = M - T \frac{dy}{dx} + B\varphi,$$

$$B' = B + T \frac{dz}{dx} - M\varphi,$$

$$T' = T - B \frac{dz}{dx} + M \frac{dy}{dx},$$

$$N' = N + V \frac{dz}{dx} + H \frac{dy}{dx}.$$

Solving these simultaneous equations, the author gave the deflection of the beam parallel to  $z$  and  $y$ -axes, the elongation along  $x$ -axis and the rotation in the  $xy$ -plane.

In the latter part of this paper the instability of a beam is discussed. K. Y.

**3. On the Design of Pondage Reservoir for Water-Power Development** (Japanese). **Tatsuji MATSUNO.** [J. Civ. Eng. Soc., XI., 3 (1925), 523-564, with pl.]—From the study of the unit-load-diagram, in which the maximum load is taken as a unity and the other load is expressed as its fraction, the author obtained the following equations:—

$$T_o = \frac{a}{1-b} (1-f),$$

$$T_m = \frac{a}{1-b} \left( \frac{1}{f} - 1 \right)$$

where

$a$  = area above load-factor line in unit-load-diagram,

$b$  = ordinate of load-factor line in given unit-load-diagram,

$f$  = ordinate of load-factor line as variable,

$T_o$  = time-duration of flowing full capacity of water in pondage reservoir, when fully loaded,

$T_m$  = time-duration of flowing full capacity of water in pondage reservoir under mean loading.

In the above formulae the author finds out that the value  $\frac{a}{1-b}$  is almost constant in a given district, and that there are three different districts in Japan in which  $\frac{a}{1-b}$  is 5, 6, or 7.

It is proved that any unit-load-diagram can be reduced to a straight line in all pondage reservoirs, of whatever kind they may be — insufficient, excess or balanced.

The above facts simplify the various problems on the present subject. The following items are also described:—

- (1) Parallel operation of water-power plants with and without pondage reservoirs.
- (2) Parallel operation of water and steam power.
- (3) Loss of head when the pondage reservoir is used.
- (4) Effects of position and capacity of a pondage reservoir on the total output.

K. Y.

**4. Resistance of Materials to Torsion, with Special Reference to that of Reinforced Concrete** (Japanese). **Takenosuke MIYAMOTO.** [J. Civ. Eng. Soc., XI., 4 and 6 (1925), 661-846 and 1273-1420, with fig. and phot.]—In the first part the author discusses the general theory of torsion in elastic materials.

He also describes (1) the shearing stress in shafts of various sections, (2) the torsional modulus of a shaft, (3) the work performed in a shaft, (4) the torsional angle of a shaft, and (5) the deformation of the surface of a shaft.

In the second part are given: (1) the collapse of a shaft, (2) the full details of the economical shape of a shaft, (3) the resultant of the compound stresses in a shaft, and the modulus of rigidity.

In the third part the author introduces a formula which is transformed from the general formula of the torsion of an elastic material, and is applicable to reinforced concrete screw piles.

He discusses the modulus of elasticity of concrete and the tests on the strength and torsional resistance of concrete made by several investigators.

In the fourth part the author works out his formulae for the designing a reinforced concrete screw shaft, and also considers the following subjects:—

- (1) Various moduli of elasticity.
- (2) The modulus of rigidity.
- (3) Poisson's ratio.
- (4) The distribution of stresses in a concrete shaft.

K. Y.

**5. *On the Design of Reinforced Concrete Arches*** (Japanese). **Muneharu ŌKAWADO.** [J. Civ. Eng. Soc., XI., 5 (1925), 907-994, with fig. and pl.]—An elaborate graphic method of designing a reinforced concrete arch is given in this paper.

In the first part, the general theory of arches is discussed, and studied, and the equilibrium-curve is obtained by the writer's graphic method.

Multiplying certain coefficients to the loaded height, he reduced the curved, loaded line into nearly a horizontal one. In this way the equilibrium-curves can always be obtained. The axial line of the arch rings is to be made to coincide with these equilibrium-curves.

Assuming a certain crown thickness, the writer determines any arch ring of such a thickness that the condition of the middle third is satisfied. (He insists that it is most economical when the reinforcement in the concrete is subjected to the tensile stresses.) Then he works out formulae to determine the form of an arch and the thickness of arch rings. The writer gives a graphic solution for application to these formulae.

As an example, description is given of the reinforced concrete arch of a railway bridge, 108 ft. in span, over the River Kanda designed by the writer. This actual example proves that the axial line of the arch rings almost coincides with the pressure-line given by the elastic theory.

K. Y.

**6. *Principle involved in the Design of Gravity Dam for Reservoirs*** (Japanese). **Nagaho MONONOBE.** [J. Civ. Eng. Soc., XI., 5 (1925), 995-1158, with fig. and pl.]—A simple and rational method for designing a gravity dam, bearing in mind its seismic stability, is described in this paper; the method is now widely applied in this country. At the beginning of the paper the developments and present status of dam construction in the world and some characteristic features of the Japanese ones are mentioned. The author gives his views on the following questions:— (1) The specific gravity of the material in the construction of a dam, (2) the water pressure on the dam, (3) the buoyancy within a dam, (4) the effect of earth pressure (due to the sediments of sand and gravel), (5) seismic stability, (6) the allowable strength of the material of the dam, and (7) the frictional angle. He emphasizes the fact that the water pressure on a dam is increased by seismic action.

He then proposes a new method for designing the section and form of a dam by a simple calculation in place of the tedious method generally used. The section and form of the lowest part of a high dam are determined analytically in order to keep the direct stress or the principal stress under the allowable strength of the material used. The proposed standard section is proved to satisfy all the conditions for stability, and some corrections necessary for the practical case, are given. The ideal form of an overflow is also obtained theoretically.

The author also gives some actual examples in which his method is applied.

K. Y.

**7. *On the Maximum Number of Trains*** (Japanese). **Shinta MATSUNAWA.** [Bull. Imp. Gov. Rwy. Research Office, XIII., 9 (1925), 821-972, with diag., fig. and phot.]—The capacity of a railway line is studied. The following conditions are shown to have a great effect on the line capacity or on the train diagrams:—

- (1) Effect of the speed of trains on (a) single or double tracks, (b) local or through service, and (c) uniform or non-uniform block distance.
- (2) Trains on the same track in the same direction, in the case of (a) equal speed, (b) high and low speed trains mixed, (c) various speed of the express trains mixed.

- (3) Distance of train service.
- (4) Distribution of train services on the same line.
- (5) Effect of time required for loading parcels or newspapers.
- (6) Effect of shunting in the station yard.
- (7) Effect of stopping and retardation.
- (8) Effect of level crossings.
- (9) Effect of installations.
- (10) Effects of the arrangement of tracks of arrival and departure.
- (11) Effect of the arrangement of terminals.
- (12) Effect of the arrangement of siding.
- (13) Effect of the various kind of block system.
- (14) Effect of the kinds of braking apparatuses.
- (15) Effect of signal stations and boxes.
- (16) Effect of lead curve in a switch point.
- (17) Effect of facing points and derailling points.

The author gives practical examples for each of the above problems.

K. Y.

**8. General Theory on Seismic Earth Pressure and Some Experiments thereon** (Japanese). **Saburō OKABE**. [J. Civ. Eng. Soc., XII, 1 (1926), 123-131, with diag. and fig.] — Remarkable progress in the study of earth pressure under statical conditions has been made by many investigators, but the seismic action on the earth pressure has been little studied.

In Japan, where severe earthquakes are frequent, the stability of retaining walls should be studied not only statically but also dynamically. The writer has developed Coulomb's theory of earth pressure taking the seismic force into consideration.

The maximum earth pressure due to vibrations was measured with a pressure measuring box, fixed on a shaking table, and it was shown that the writer's formulae were nearly correct. The change of earth pressure during one cycle of vibration, and the permanent increase of statical pressure due to the vibration, were also studied.

The friction between earth and the back surface of a retaining wall was shown to have a certain influence on its stability, and accordingly the stability of a retaining wall depends upon the form of its back surface.

N. S.

**9. An Experimental Study of Poisson's Ratio of Concrete** (Japanese). **Heigaku TANABE**. [J. Civ. Eng. Soc., XII, 2 and 3 (1926), 159-228 and 549-626, with fig., phot. and tables.] — So far the test pieces used for the present study have been either prismatic bars subjected to axial load or twisting. The author used reinforced concrete beams as test pieces, which were subjected to bending, and measured the deformations of the beam on the upper and lower surfaces both in the longitudinal and in the transverse directions. From the result of the experiments, the following conclusions were reached:—

(1) Poisson's ratio of concrete is dependent on the intensity of the stresses. In the compression-fibre, so long as the stress-intensity  $f_c$  is small, i. e., under about 60 kg./cm.<sup>2</sup>, Poisson's ratio  $\sigma_c$  increases with the growing stress, but it remains almost constant after that limit is passed and shows a tendency to decrease as the breaking stress is reached.

In the tension-fibre, Poisson's ratio  $\sigma_t$  increases with the growing intensity of the stress  $f_t$  and becomes higher as the cracking stress is approached.

(2) Within the limit of the allowable stress, the value of Poisson's ratio of concrete may be assumed to be  $\sigma_c=5.6$  in the compression-fibre and  $\sigma_t=7.8$  in the tension-fibre.



(3) Poisson's ratio of concrete is affected by the age of the concrete and increases both in the compression and tension-fibres as the concrete becomes older. As the mean value, the author found  $\sigma_c=5$  and 6 in the compression-fibre and  $\sigma_t=7$  and 9 in the tension-fibre at the ages of 7 and 45 days, respectively. Author.

**10. Construction of Multiple Storied Building subject to Earthquakes** (Japanese). **Kenzaburō MAJIMA.** [J. Civ. Eng. Soc., XII., 2 (1926), 229-303, with fig. and pl.]—This is a continuation of the author's previous paper "On the Phases of Oscillation of Structure caused by Earthquake Motion" and in accordance with his theory, he proposed a unit-set system of construction as being the best for an earthquake-proof structure. In this construction each set is composed of four columns rigidly connected by the necessary number of girders on each story. Such unit-sets, spaced in the required manner and connected together loosely by floor girders, may constitute a building of any size required. As each element of the structures vibrates with the same period and with the same form of deflection, the structure, as a whole, may vibrate also with the same type. Thus such a construction is simpler than any other, and renders calculations very easy.

According to the forgoing principle, the author treated the subject in detail, as follows:—

- (1) Stress and deformation due to lateral force.
- (2) Type and period of free vibration.
- (3) Forced vibration due to earthquakes.
- (4) From the maximum deformation due to forced vibration, the corresponding value of "potential" at any point of structure may be calculated, and from it the stress in each member may be found statically, without difficulty.
- (5) Several examples are given to show the effects of earthquakes upon the structure.

N. S.

**11. Report on the Construction of the Yokotone Canal Lock** (Japanese). **Kichizō NAKAGAWA.** [J. Civ. Eng. Soc., XII., 3 (1926), 391-547, with fig., phot., pl. and tables.]—The lock is of the double mitre-gate type with eight steel gates of two different sizes. The effective length and breadth of the lock are 300 feet and 36 feet respectively and the depth of the sills from mean low water level is 8.6 feet.

The side walls of both gate chambers are of vertical front concrete gravity type with brick and stone facing. The sides of the lock-chamber being 1:1 slope, are pitched with concrete blocks. For the foundation twenty-eight walls were sunk.

A mixture of sulphur and graphite was used as binding material between stone and metal and was found to be far superior to those generally used.

After the completion of the work numerous experiments on the velocity and discharge of water through the lock with all gates open, were made and the results obtained compared with those calculated by theoretical formulae. Author.

**12. Wireless Tower provided with Stays** (Japanese). **Isamu KUSAMA.** [J. Civ. Eng. Soc., XII., 4 (1926), 649-758, with diag., fig., and phot.]—It is generally laborious to find the tensions of the stays of towers provided with numbers of steps and moreover the results are uncertain owing to neglecting the effect due to the sag of the stays. In this paper the author proposed a simple method of analysis of the tensions of the stays and of the moments in the tower body, by introducing the theory of continuous beam and pre-determining the size of stays so as to keep the supports (the points of connection of

stays to the tower) always straight. General formulae for towers provided with stays — number of steps up to eight — equally spaced, are given for uniform varying wind-pressure, the validity of the formulae being confirmed experimentally. The characteristics of the section of stays determined by the new method and their bearing on economy are studied. The method of practical calculation by the new method are also explained. The method is applicable to towers with varying flexural rigidity without any appreciable error. The proper sag and the amount of the initial tension of stays are investigated. The descriptions are made on the Kemigawa 90 m. wireless tower designed by the author. Author.

**13. Comparative Merits of Movable Weirs of Different Types and the Action of a Bear-Trap Weir** (Japanese). **Saburō OKABE**. [J. Civ. Eng. Soc., XII., 4 (1926), 759-781, with fig.]—In this paper the following points are dealt with:—The characters of various movable weirs, and their advantages and disadvantages; ideal specifications for the construction of a movable weir; the selection of type according to the object of its installation.

In the appendix the theory of the motion of the Bear-Trap weir which was designed by the writer and filled at the entrance of the diversion channel of the river Shinano in Niigata Prefecture. Model experiments for designing an improved type; and the theory of the motion of the weir which well conforms to the results given by practical tests.

Author.

**14. On the Discharge of Rivers in Kyūshū** (Japanese). **Shizuo ABE**. [J. Civ. Eng. Soc., XII., 4 and 5 (1926), 783-849 and 975-1092, with fig. and tables.]—This paper embodies the results of investigations by the Department of Communication on the discharge of rivers in Kyūshū, in which the author participated as the engineer in chief in Kyūshū.

With regard to the run-off relations, the coefficient of run-off sums was the chief object of investigation. According to the author's view the nature of river discharge cannot be judged merely by the coefficient of run-off. The author tried to make the "underground storage" (in a wide sense)—the total amount of water contained in the drainage basin—the chief object of investigation, the flow of underground water, and the underground temperature being simultaneously taken into consideration.

Author.

**15. Self-supporting Wireless Tower of Reinforced Concrete built at Haranomachi** (Japanese). **Isamu KUSAMA**. [J. Civ. Eng. Soc., XII., 5 (1926), 891-963, with fig., pl. and tables.]—This paper describes the calculations for the design of 660 ft. self-supporting tower built at Haranomachi, the highest reinforced concrete tower in the world. In the first two chapters fundamental formulae for the shaft and base are studied, and the general directions and assumptions for designing high towers are explained. The third chapter is devoted to the design of the 660 ft. main tower and in the remaining chapters the design of auxiliary towers of 350 ft., 200 ft. and 100 ft. high is dealt with.

Author.

**16. On Multiple-Node Vibrations of Structures caused by Earthquakes** (Japanese). **Kensaburō MAJIMA**. [J. Civ. Eng. Soc., XII., 5 (1926), 965-974, with fig.]—In papers, "On the Phases of Oscillation of Structures caused by Earthquake Motion" (Journal of the Society Vol. X, No. 1.) and "Construction of Multiple Storied Buildings sub-

jected to Earthquakes," (Vol. XII, No. 2.), the author treated of the subject for the vibration having one nodal point, those with two or more nodes being left untouched. Through further researches on the subject, he recognized the fact, that the effect of the vibration with multiple-nodes upon the strength of structures is not insignificant.

In this paper, as a supplement to the author's past work, the cause of the occurrence of multiple-node vibrations by an earthquake motion, the form of deflection and the amount of stress and strain induced thereby, and other items are described. Author.

**17. On the Consistency and Induration of Portland Cement** (Japanese). **Yashichi YOSHIDA.** [J. Civ. Eng. Soc., XII., 5 (1926), 1095-1130, with fig. and tables.] — This paper describes the result of investigations on the consistency and induration of Portland cement paste.

Partial corrections of Standard Specification and Tests for Portland Cement are proposed. Author.

**18. On Harbour Construction on Sandy Coasts** (Japanese). **Bunshirō ARAKI.** [J. Civ. Eng. Soc., XII., 6 (1926), 1155-1199, with fig., phot. pl. and tables.] — The items contained in the paper are as follows:—

Principal transporting agents by which sand-drifts are moved; erosive and accretive changes on the beach and the shallow bottom, caused by on-shore, oblique, and combined waves. Nature of sand ridges, and erosion and accretion of sandy coasts in calm and and stormy weather, and their effects upon harbours situated on sandy coasts; waves cause drifting sands on beaches and shallow bottoms according to their conditions, not like a kind of wave motion; effects of tides and winds upon drifting sands; directions of the motion of drifting sands and agents causing the motion; effects of drifting sands on harbours; some examples of harbours constructed on sandy coast. Author.

**19. Schwingungen des im Grundriss gekrümmten Trägers.** **Yōsei YAMADA.** [Mem. Fac. Engg. Hokkaidō Imp. Univ., I., 1 (1926), 24-55, with fig. and tables.] — Ein an einem oder beidem Enden in Stützen eingebauter Träger, der im Grundriss eine Kurve bildet, unterliegt an jedem Querschnitte sowohl Biegungs- wie Drehmomenten. An den Stützen treten Einspannungsmomente beider Arten in Erscheinung, und so lange diese nicht ermittelt sind, ist das Moment, das irgent einen Bruch verursachen könnte, nich zu bestimmen. Wenn Momente und Reactionen an den beiden Enden des Trägers gegeben sind, so wird das Moment an einem beliebigen Punkt des Trägers ohne weiters ermittelt werden können.

Die Verschiebung eines beliebigen Punktes wurde in drei Richtungen, nämlich in der Richtung der Tangente, in der der Normalen und in der der vertikalen Richtung an demselben Punkte betrachtet.

Wenn der Träger eine bewegte Last hat, so muss ausser dem Gewicht auch die Fliehkraft berücksichtigt werden. Dieses Fliehkraft ist je nach der Stellung der Last verschieden. Die Verschiebungen eines beliebigen Punktes des Trägers ändern sich mit dem Stellungswechsel der Last.

Man kann sich solche Verschiebungen auch so vorstellen, als ob sie unter veränderlichen Lasten an dem Punkte ausgeführt werden. Der Verfasser hat sich die Sache so gedacht, dass diese veränderlichen Lasten die durch Seile und Rollen in den drei Richtungen wirkenden Gewichte sind.



Es wird in dieser Dissertation gezeigt, wie solche veränderlichen Lasten ermittelt werden können und in welcher Formel die Beziehung der durch diese veränderlichen Lasten verursachten Verschiebungen und der Zeit zueinander steht. Verfasser.

**20. In der Ebene gekrümmte Träger und Rahmensystem mit gekrümmten Riegeln.** Yōsei YAMADA. [Mem. Coll. Engg. Kyūshū Imp. Univ., III., 7 (1926), 307-408, with fig. and tables.] — Es ist ziemlich umständlich das Elastizitätsproblem des in der Ebene gekrümmten Trägers zu lösen, da in der Querschnitten ausser den Biegungs-, Schub- und Achsialspannungen auch Verdrehungsspannungen auftreten.

Erstens hat der Verfasser einen im Grundriss gekrümmten, an beiden Enden eingebauten und einfach auf den Zwischenstützen ruhenden Träger, der in der wagerechten Ebene eine Kurve  $y=f(x)$  bildet, behandelt.

Es wurden einige Formeln eingeführt, die die Biegemomente, das Drehmoment und den Achsialdruck an einem beliebigen Punkt eines solchen Trägers durch das Glied  $\frac{dy}{dx}$  oder  $f'(x)$  an demselben Punkt ausdrücken.

Dieser Gedanke gelangt in der vorliegenden Abhandlung überall zur Anwendung.

Ferner hat der Verfasser solche Formeln nicht nur auf eine einfache Kurve  $y=f(x)$ , sondern einem aus zwei oder mehr als zwei Kurven zusammengesetzten Träger angewandt.

Die Ursachen der Verschiebung an einem beliebigen Punkt des Trägers sind ausser Biegemoment und Drehmoment, Achsialkraft und Einflüsse der Positionsänderung und der Drehung der beiden Enden und der Stützung.

Die Verschiebung eines beliebigen Punktes wurde in drei Richtungen, nämlich in der Richtung der Tangente, in der der Normalen und in der der vertikalen Richtung an demselben Punkte betrachtet.

Um einen Formel, in der die Verschiebungen eines beliebigen Punktes des Trägers gezeigt werden, zu ermitteln — wenn eine nach beliebigen Richtung neigende Last an einem beliebigen Punkte den Träger angreift — wurde die Last in drei Komponenten in Tangentenrichtung, Normalenrichtung und Lotrichtung an dem Angriffspunkt zerteilt, und die gesuchten Verschiebungen wurden von den drei entsprechenden Richtungen aus betrachtet. Letztens hat sich der Verfasser ein Rahmensystem aus einem gekrümmten Riegel und vielen Ständern zur Aufgabe gestellt. Die rechnerische Behandlung eines solchen Rahmensystems erscheint infolge der hohen statischen Unbestimmtheit fast undurchführbar.

Verfasser.

**21. On the Coefficient of Linear Expansion of Neat Cement, Mortar, Brick and Ayashi Stone** (Japanese). Shichirō UCHIDA. [Rep. Lab. Reconstruction Bureau, 7 and 8 (1926), 30-71 and 7-13, with fig., pl. and tables.] — The coefficients of linear thermal expansion of neat cement, mortar, brick, stone etc., were measured under high temperature in order to determine their fireproof qualities. The sizes of test pieces used were 5 mm. dia. and 2 cm. long. Some of the results are shown in the following table:—

Coefficients of Expansion.			
Temp. C.°	Ayashi stone.	Ordinary building brick.	Neat cement, mixed with 27% water, age 15 months, stored in water.
50-100	0.80	0.51	0.80
100-200	0.90	0.81	1.13



200-300	0.90	0.81	1.38
300-400	1.00	0.80	1.63
400-500	1.10	0.80	1.72
500-600	1.50	—	1.82
			Author.

**22. *A New Method for Testing the Workability of Concrete*** (Japanese). **Tokujiro YOSHIDA.** [Tech. Jour. Kyûshû Imp. Univ., I., 4 (1926), 159-174, with phot., pl. and tables.]—This paper describes the results of a series of experiments conducted for the purpose of determining the value of a new method for testing the workability of concrete.

The principle of the test lies in the fact that the workability of concrete can be determined from the diameter assumed by a pasty concrete mass when dropped on a plate in a standard manner.

This ensures measuring the workability of concrete as a whole mass, not in the segregated concrete made of water, cement paste and aggregate.

Hence it accurately measures the workability of concrete or mortar for all workabilities varying from the dry mass to those workabilities which are so fluid that water and laitance will flow away from the coarse aggregate, and it may be considered to throw some light on the workability measurement of concrete.

Author.

**23. *The Discrimination of the Quality of Brick by Means of Sound*** (Japanese). **Jûichi OBATA and Yahei YOSIDA.** ["Zatsuroku" Aeronaut. Research Inst. Tôkyô Imp. Univ., 22 (1926), 205-211, with fig. and pl.]—A systematic study was carried out to find the relation between the quality of brick and the pitch of sound produced by striking it with a hammer. More than thirty specimens, which were selected among several hundreds, were tested. The pitch of sound was determined by recording the sound with a condenser microphone and an oscillograph. Young's modulus and compressive strength were also determined in the majority of cases. Linear relations were found between the pitch of sound and the Young's modulus as well as the compressive strength.

Compressive strength (in lb. per sq. ins.) =  $\frac{100}{35} \cdot n - 1500$ , where  $n$  is the pitch of sound.

The effect of absorbed water was also studied.

Authors.

**24. *On the Strength of Reinforced Brick Beams*** (Japanese). **Shigeyuki KANAMORI.** [J. Civ. Eng. Soc., XI, 1 (1925), 35-190, with fig., phot. and pl.]

**25. *On the Lifting of Railway Tracks by Freezing*** (Japanese). **Takane INOUE.** [J. Civ. Eng. Soc., XI, 2 (1925), 285-308, with fig. and phot.]

**26. *Report on the Construction of the Tone-river Bridge at Kurihashi*** (Japanese). **Kusuo AOKI.** [J. Civ. Eng. Soc., XI, 2 (1925), 309-434, with fig., phot. and pl.]

**27. *Regulation of Fresh Air Supply in Tunnelling*** (Japanese). **Hitoshi TAKIYAMA.** [J. Civ. Eng. Soc., XI, 6 (1925), 1213-1272, with fig.]

28. *New Design for the Retaining Wall of a Passenger Platform* (Japanese). **Takane INOUE**. [Bull. Imp. Gov. Rwy. Research Office, XIII., 3 (1925), 207-215, with fig. and phot.]

29. *The Minimum Headway of Electric Cars* (Japanese). **Heiroke ŌISHI** and **Tamotsu TAKE**. [Bull. Imp. Gov. Rwy. Research Office, XIII., 9 (1925), 973-1004, with diag., fig. and pl.]

30. *Report on Earthquake Damage to the State Railway at and near Toyo-oka and Kinosaki* (Japanese). **The Imperial Government Railway Research Office**. [Bull. Imp. Gov. Rwy. Research Office, XIII., 9 (1925), 1005-1012, with phot. and tables.]

31. *On the Rock Tunnel* (Japanese). **Ryōkei ONO**. [Bull. Imp. Gov. Rwy. Research Office, XIII., 10 (1925), 1079-1088, with fig.]

32. *The Development of Suburban Railways near Tōkyō* (Japanese). **The Imperial Railway Association**. [J. Imp. Rwy. Assoc., XXVI., 2 (1925), 61-72, with diag.]

33. *Report of the Committee on the Rapid Transit Railways of Tōkyō* (Japanese). **The Imperial Railway Association**. [J. Imp. Rwy. Assoc., XXVI., 3 (1925), 113-122.]

34. *Reinforcing the Piers of the Rokugō River Bridge* (Japanese). **Norisuke ITSUNO**. [J. Civ. Eng. Soc., XII., 1 (1926), 133-152, with fig., phot. and pl.]

35. *On Subway Construction* (Japanese). **Chūsaburō NAKAYANA**. [J. Civ. Eng. Soc., XII., 6 (1926), 1201-1212, with fig., phot. and pl.]

36. *Report on the Construction of Floating Landing Stages at Imabari Harbour* (Japanese). **Isao SANTŌ**. [J. Civ. Eng. Soc., XII., 6 (1926), 1213-1228, with fig. and pl.]

37. *On the Disintegration of Concrete and Mortar and the Corrosion of Rails in Ōsakayama Tunnel on the Tōkaidō Line* (Japanese). **Chūichi CHŌ**. [Bull. Imp. Gov. Rwy. Research Office, XIV., 3 (1926), 163-179.]

38. *On the Linear Thermal Expansion of Neat Hydrated Portland Cement* (Japanese). **Shichirō UCHIDA**. [Rep. Lab. Reconstruction Bureau, 7 (1926), 72-74, with a fig.]

39. *Slag Cement Concrete* (Japanese). **Tokujiro YOSHIDA**. [Tech. Jour. Kyūshū Imp. Univ., I., 1 (1926), 1-10, with phot., pl. and tables.]

**40. *Report of the Investigation Committee on the Urban and Suburban Rapid Transit System of Ōsaka*** (Japanese). **The Investigation Committee.** [J. Imp. Rwy. Assoc., XXVII., 1 (1926), Supplement, 1-68, with diag., maps and tables.]

**41. *Report of the Investigation Committee on the Traffic of Tōkyō and Yokohama and their Suburbs*** (Japanese). **The Investigation Committee.** [J. Imp. Rwy. Assoc., XXVII., 3 (1926), Supplement, 1-38, with diag., maps and tables.]

**42. *Japanese Method of Port Administration and the Latest Practice in Construction and Cargo Handling at the Ports of Japan.*** **Isamu HIROI.** [Kōwan, IV., 10 (1926), 9-10.]

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## MECHANICAL ENGINEERING (1—30).

1. *On the Transmission of Power between Belt and Pulley.* **Hisakazu NOGUCHI.** [J. Soc. Mech. Eng. Tokyo, XXIX., 106 (1926), 49-64, with diag., fig. and tables.]—In this treatise, the author has worked out the variation and the distribution of the tension and the velocity of the belt over the contact between the belt and belt pulley, by considering the elastic elongation of the former.

Though several authorities have hitherto explained the phenomena of creeping due to the elastic elongation of the belt, all are rather in a sense indistinct.

The author's treatise makes clear the fact in an exact way and the result thus obtained is verified by actual experiments. Author.

2. *On the Castings for Diesel Engines* (Japanese). **Harukichi MATSUURA.** [J. Soc. Mech. Eng. Tokyo, XXIX., 106 (1926), 65-89, with fig. and tables.]—A report of experiments on the strength of cast iron, and it was concluded that semi-steel high in manganese has suitable qualities for Diesel engine castings. See also the abstract in the metallurgical section of this journal. K. K.

3. *Initial Length of Belt* (Japanese). **Hisakazu NOGUCHI.** [J. Soc. Mech. Eng. Tokyo, XXIX., 107 (1926), 123-134, with fig.]—Hitherto, in the calculations relating to belt transmission, the elastic elongation of the belt is not, in general, taken into account. Accordingly a very rough formula or rather guess work has been employed to find the initial length or the initial tension of the belt. The result leads to an un-economical design, too much allowance being made on account of vagueness. In this brief treatise, a formula, capable of calculating the initial length or the initial tension of belt required for the necessary operative condition, is worked out, in which the weight of the belt itself and the elastic elongation thereof are taken into account. Thus, the ambiguity having been removed, we can realize the most economical design with safety and reliability. Author.

4. *The Theory of the Centrifugal Pumps in a Practical Form and its Extension.* **Katsuzō OKAMOTO.** [J. Soc. Mech. Eng. Tokyo, XXIX., 108 (1926), 173-234, with fig. and tables.]—The author gives a series of formulae for the manometric head and impelling horse power of centrifugal pumps, which he claims himself to be the originator. The author recommends a general formula  $\cot \alpha = M\epsilon^n + N$  for vane curve, where  $\alpha$  is the angle between the tangent at a point on the vane curve and the opposite direction of the rotation of impeller, and  $\epsilon$  is the ratio of radius of that point and the inner radius of impeller, and  $M$ ,  $N$ ,  $n$  are constants depending on the form of vane. Using this curve as the vane curve, the author gives the above said formulae for various cases. The results are unsuitable to be abstracted here. Some of the results were confirmed by experiments made by him. K. K.

5. *Lubrication of High-Speed Journals and the Properties of the Oil Used* (Japanese). **Tsuneo HAYASHI.** [J. Soc. Mech. Eng. Tokyo, XXIX., 110 (1926),



319-373, with fig. and tables.]—A report of the experiment made by the author. The subject is discussed from the practical point of view. K. K.

**6. Calculation of the Valve-Gear for Three-Cylinder Locomotive Engines** (Japanese). **Sukesige TAGA**. [J. Soc. Mech. Eng. Tokyo, XXIX., 110 (1926), 374-386, with fig.]—There are two kinds of valve-gears for a three-cylinder locomotive; in one of them each cylinder has an independent valve-gear and in the other the middle valve is driven by the combined action of the two outer valve-gears. The former is the same as that of the ordinary two-cylinder locomotive, so in this paper the writer treats of the latter only.

In this paper the method of calculation for the latter kind of valve-gear is discussed for all cases, that is

- (1) When three cylinders lie in one plane and the cranks are at 120 degree difference.
- (2) When the middle cylinder inclines and the cranks are at 120 degree difference.
- (3) When the middle cylinder inclines and the crank angles are correspondingly changed.

Furthermore, the method of calculation is given when the clearances of the pin joints due to wear are taken into consideration. Author.

**7. Hysteresis Phenomena in Multiple-Effect Refrigerating Machines.** **Haruhisa INOKUTY**. [J. Soc. Mech. Eng. Tokyo, XXIX., 111 (1926), 387-396, with fig. and tables.]—It is found theoretically and experimentally that the temperature of the delivery gas of the multiple-effect refrigerating machine describes a hysteresis loop against the variation of separator-pressure. Utilising this phenomena, the best separator-pressure of the multiple-effect cycle can be found very easily without calculation, while the machine is in actual operation. It is shown that, with an improper separator-pressure, the losses in the refrigerating capacity and the efficiency are very great, but they may be avoided by the knowledge of this phenomena. Author.

**8. A Study of the Potential Flow of Gas through the Poppet Valves.** **Keikichi TANAKA**. [J. Soc. Mech. Eng. Tokyo, XXIX., 111 (1926), 397-408, with fig.]—On the potential flow of fluid through a plane-seated valve, a paper has been recently read by Dr. B. Eck, in which he assumes its flow in two configurations. Setting aside his first case in the small lift, the writer here refers to the second case of the increased lift. It is the writer's opinion that this flow configuration is analogous to that of the ordinary conical-seated valve in its increased lift, and this paper aims at solving the case of the tulip-type valve with conical seat in its increased lift, assuming a similar configuration to the above two, and at comparing this result with those derived by Eck, in other words, with those of the plane and the ordinary conical-seated valves. Author.

**9. Short Note on the Calorific Power of Hydrocarbon Fuels.** **Kango TAKEMURA** and **Toyoji NARITA**. [J. Soc. Mech. Eng. Tokyo, XXIX., 111 (1926), 409-411, with tables.]—This shows mathematically that the calorific power of the hydrocarbon of the paraffin series decreases with the increase of specific gravity, but with benzene series the case is just the reverse, while the naphthene series gives no change at all. Authors.

**10. *An Investigation on the Grab*** (Japanese). **Seturō NAGAWO.** [J. Soc. Mech. Eng. Tokyo, XXIX., III (1926), 412-435, with fig.]—This paper is the first report of author's practical investigations on the grab, and contains, (1) Introduction of two novel driving mechanisms of the grab of his original design, with descriptions of various kinds of existing ones, (2) Investigations on the counter weight of the grab including his own system, (3) Investigations on the time required for one cyclic operation of the grab, and the following empirical formula based on his experimental data:—

$$t = T_t + \left( \frac{60S}{v} + m\ell' \right) + n'l_h + F_t,$$

where  $t$  is time required for one cyclic operation of grab in sec.,  $T_t$ , time required for operating and closing of grab in sec.,  $v$ , speed of rope of grab in m./min.,  $S$ , total moving distance of grab in m.,  $m$ , number of changes of direction of motion of grab.,  $\ell'$ , time required for breaking in sec.,  $l_h$ , time required for one handling in sec.,  $n'$ , number of handlings.,  $F_t$ , time in sec. required for miscellaneous operations not included in the preceding items. Author.

**11. *Elasticity of Cast Iron at Ordinary and High Temperatures.*** **Ihei SUGIMURA.** [J. Soc. Mech. Eng. Tokyo, XXIX., II2 (1926), 437-473, with fig. and tables.]—A report of the tension test of cast iron at various temperatures, temperature ranges 100° to 700° C. According to the results, ordinary cast iron loses its elasticity more particularly at 600° C. K. K.

**12. *A Contribution to the Test Code of Water Tube Boilers.*** **Kazuo KUMABE.** [J. Soc. Mech. Eng. Tokyo, XXIX., II2 (1926), 474-480, with fig. and tables.]—In the evaporation test of steam boilers, the quantity of heat absorbed by the furnace wall during the heating period will be large compared with that after the thermal stationary state is arrived at. The author proposes to establish some rule for the preliminary firing in such cases to limit the error of result within a certain range. The formulae to calculate it are given with an example. Author.

**13. *On the Measurement of Elastic Elongation in Tension Tests*** (Japanese). **Tsuruzō MATSUMURA.** [J. Soc. Mech. Eng. Tokyo, XXIX., II2 (1926), 497-505, with fig. and tables.]—The author discusses the error produced by Bauschinger, Hayeslewis, and Martens' type of extensometer and proposes the adoption of a cardioid or practically a circular scale for the latter type to get a correct result. At the end of the paper his own type is introduced. K. K.

**14. *The Effect of a Cavity in an Elastic Body.*** **Iwazō NAKAYAMA.** [J. Soc. Mech. Eng. Tokyo, XXIX., II3 (1926), 507-526, with fig. and tables.]—By using a potential function, the general solution for the effect of a cavity or a hole under some constant stresses at a great distance from the cavity in an infinitely elastic body are derived from the results for a circular hole already studied in a recent paper. The constant stresses treated are the tensile stress, the shearing stress and the constant hydrostatic pressure in the cavity and the solutions are worked out for a spherical or ellipsoidal cavity and an elliptical hole. Author.

**15. *Researches on the Piston Ring.*** **Masatoshi ŌKŌCHI and Keikichi EBIHARA.** [J. Soc. Mech. Eng. Tokyo, XXIX., II3 (1926), 527-564, with fig. and tables.]

— With a view to improving the piston ring, the amount of the pressure exerted by the piston ring on the cylinder wall was at first ascertained by means of a specially designed apparatus; to which piezo-electricity of quartz was applied so as to get the configuration of the pressure distribution.

Tests of the many sample pieces of commercial rings on markets, show that there is surprisingly a wide range of pressure irregularity which is naturally an undesirable function for the efficiency and maintenance of the engine.

In the paper, a ring which exerts a nearly uniform pressure on the cylinder wall is described and the maximum stress of the ring under working conditions is calculated mathematically, and a 3-HP four-cycle horizontal Diesel engine which is in the laboratory in their Institute was used for the experimental researches in connection with the effect of the pressure of rings on gas tightness, as well as for determining the frictional resistance between the piston ring and the cylinder wall.

Authors.

**16. *An Investigation on the Grab, Second Report* (Japanese). Seturō NAGAWO.** [J. Soc. Mech. Eng. Tokyo, XXIX., 113 (1926), 565-583, with fig.]— The author describes his new design for a grab. He claims it to be simpler to handle than the ordinary one, thus only one handle is sufficient to operate it, and moreover the capacity of the machine is increased five to twelve times with the same power of motor, and three to seven times the ordinary one with the same size of grab.

K. K.

**17. *Note on Cooling and Contraction of Iron Castings*. Ihei SUGIMURA.** [J. Soc. Mech. Eng. Tokyo, XXIX., 114 (1926), 585-594, with fig. and tables.]— The paper deals with:— first, the cooling and contraction curves of rapidly and slowly cooled cast iron from melting to ordinary temperatures obtained by a special apparatus of the author's own design, and the results are discussed into some detail, formulating them finally in a series of mathematical expressions; second, the density and shrinkage of cast iron which occlude air while pouring is discussed from the results of experiments on high and low-head castings which occluded air in different amount, and the conclusion drawn is shown as follows: porous or gas-occluded cast iron of lower density shrinks more than less porous iron of higher density.

Author.

**18. *On the "Ikegai" High-Speed Diesel Engine* (Japanese). Shinichi IDA and Soichi OKU.** [J. Soc. Mech. Eng. Tokyo, XXIX., 114 (1926), 595-618, with fig. and tables.]— This paper contains the various results of experiments carried out on high-speed Diesel engine for driving out dynamo at the testing shop of the Ikegai Iron Works, Ltd.

The authors describe the general characteristics required by dynamo engines, and the points which should be controlled automatically in case of air injection Diesel engines. Then they draw attention to the fact that most Diesel engines in use require to adjust the pulverizer properly according to the different quality of fuel oil in use.

As to the experiment on the Diesel engine made by the authors, they faced many difficulties in above mentioned points, as the engine itself was the type of a specially light construction following the requirements of its customer. These difficult points and the method followed to obviate these difficulties are described in detail.

It is concluded that "Ikegai's" patent fuel-injection valve which has been in use sometimes for engines of the usual type has proved to be equally successful for special light-



type engines, when assisted by the governing system which has been developed by the authors during the trials of the engine. Thus the combination of parent injection-valve and special governing system enabled its speed regulation to a very narrow range, its running to be very smooth and steady, and use of any grade of fuel oil possible without adjustment of the pulverizer as other types of Diesel engine require. Authors.

**19. Investigations of the Efficiency of Diesel Engines.** Mitsuyosi INŌ. [J. Soc. Mech. Eng. Tokyo, XXXIX., 115 (1926), 619-675, with fig. and tables.]—The writer treats of the theoretical thermal efficiency of internal combustion engines taking into account practical considerations as far as possible. He compares the calculated efficiency of various cycles, using the results thus obtained. K. K.

**20. On Bending beyond the Elastic Limit.** Toshio NISHIHARA. [J. Soc. Mech. Eng. Tokyo, XXIX., 116 (1926), 711-745, with fig. and tables.]—Bending beyond the elastic limit causes "after-stresses" which increase with the curvature of the elastic line. First under certain assumptions the relation between the bending moment and the elastic line for a straight beam is found and then the distribution and the amount of the stresses are calculated. Next the expression for the elastic line and the permanent deflection of the center line are found. Finally it is shown, that the elastic limit determined by tension tests will not coincide with that obtained by bending tests. Author.

**21. A Study of Hardness** (Japanese). Isamu TAKEDA. [J. Soc. Mech. Eng. Tokyo, XXIX., 116 (1926), 746-782, with fig. and tables.]—Hardness is an important property of a material, but has no specified physical meaning. Many authorities give conventionally its different definitions, but it should be noticed that the relative values of the hardness numbers of different materials are more important than their absolute values.

The following important proposals as to the definition and the scale of hardness are given.

- (1) The hardness of a material is the resistance to the compressive deformation due to a given tool.
- (2) The hardness number is defined as the amount of energy absorbed plastically by a unit volume of the indentation produced by a tool.

Therefore we have the following equation:  $-H = W_p/V_p$ , where  $H$ =hardness number,  $W_p$ =energy absorbed plastically in kg.-mm.,  $V_p$ =plastic indentation volume in mm.<sup>3</sup>.

$W_p$  is measured by the area multiplied by a certain scale-constant in the load-indentation diagram, and  $V_p$  is the volume of the indentation after the load is removed.

The chief objects of the researches are as follows:—

(2) to find the relation between the hardness number and the load applied, and (2) the relation between the hardness number and the diameter of the ball used. With the definition and scale of hardness as above mentioned the author studied the two relations described above. Author.

**22. On the Self-Ignition Temperature of Liquid Fuel** (Japanese). Masatosi ŌKŌCHI, Katsuharu HIBI and Sitiryō HASIMOTO. [Bull. Inst. Phys. Chem. Research, V., 1 (1926), 32-42, with fig.]—Gives a brief description, first, of the general conception as to the ignition of liquid fuel in respect of the need for full knowledge of the time required for evaporation and ignition in the internal combustion engine, and the processes and results of the experiments are reported.



A drop of liquid fuel is let fall down upon a heated metallic disc, and the time-temperature curves for evaporation are obtained for several kinds of liquid fuel. There is an abrupt increase of the time required for evaporation when the disc is heated at such a temperature as to produce the spheroidal state of the dropped liquid.

By heating, the fuel drops in a cylindrical steel vessel surrounded by an electric resistance coil, the time required for self-ignition is measured with fair accuracy for the different magnitude of the fuel drops, and the time-temperature curves for ignition are plotted accordingly.

As for the time required for ignition under pressure, the said vessel is introduced into an enclosed cast-iron box subjected to high-pressure, and the pressure effect on the self-ignition curves are observed. The lower the temperature, the higher is the pressure effect.

Authors.

**23. On Recent Developments in the Theory of the Properties of Steam** (Japanese). **Shūichi YAMAGUTI**. [J. Kyūshū Soc. Mech. Eng., 15 (1926), 182-202, with fig. and tables.]—Characteristic equations for the steam recommended by several authorities are compared by the author. The authorities are, Zeuner, Rankine, Callender, Mollier, Knoblauch, Schüle, Marks and Davis, Peabody, Goodenough, Eichelberg. The author suggests Callender's equation as the best one. The tables worked out by the author to compare the equations are interesting.

K. K.

**24. Law of Elastic Failure of Ductile Metals** (Japanese). **Shigeo SASAKI**. [J. Ord. & Exp., XX., 2 (1926), 65-75, with fig. and tables.]—A new hypothesis on the law of elastic failure of ductile metals is proposed. In this hypothesis it is assumed that the failure occurs by shearing or slipping along a hypothetical plane; that the shearing resistance of the material is affected by the strain (not stress) normal to the plane of shear. The elastic failure of the material under combined stress takes place when  $X - \beta Y - \gamma Z$  exceeds a certain value, where  $X, Y, Z$  are the principal stresses and  $X > Y > Z$  algebraically;  $\beta$  and  $\gamma$  the constants peculiar to the material having a certain relation between each other. The results of Cook and Robertson's experiment seem to support the view, although further experiments are needed to confirm this.

Author.

**25. Some Results of the Tests of Railway Axles and Tires damaged in Service** (Japanese). **Aijin INOUE**. [Gijutsu-Kenkyūsho-Hōkoku of the South Manchuria Railway Co., 1 and 2 (1926), 3-34 and 27-70, with fig., phot. and tables.]—The results of the study on the physical properties of the various kinds of railway axles and tires damaged in service and also on the causes of the failure are given.

H. S.

**26. Some Experiments on the Materials for the Side Staybolts of Locomotive Boilers** (Japanese). **Aijin INOUE**. [Gijutsu-Kenkyūsho-Hōkoku of the South Manchuria Railway Co., 2 (1926), 1-17, with diag., fig. and phot.]—The author made vibration tests with a vibratory staybolt testing machine on very low carbon steel, which is now generally used as the material of the staybolt of a locomotive boiler; on low carbon steel and medium high-carbon steel in order to determine whether the former kind of steel can be replaced by the latter two or not. The positive results are shown.

H. S.

27. *On the Model-Test for Water Turbines* (Japanese). **Kazu SHOGENJI**. [J. Kyūshū Soc. Mech. Eng., 15 (1926), 174-181, with fig.]

28. *Belt Transmission* (Japanese). **Seijirō SHIKAMI**. [Bull. Military Arsenal, IV., 3 (1926), 203-226, with fig. and tables.]

29. *The Safety Factor in Metallic Materials* (Japanese). **Seijirō SHIKAMI**. [Bull. Military Arsenal, IV., 4 (1926), 305-324, with tables.]

30. *On the Method of Drilling Deep Small Holes* (Japanese). **Kikujiro SAKAI**, **Yukitsugu ICHIKAWA** and **Kyūjirō MIYAJIMA**. [Bull. Military Arsenal, IV., 5 (1926), 483-489, with pl.]

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## NAVAL ARCHITECTURE (1—17).

1. *On the Ventilation of the Engine Room in Warships* (Japanese). **Hitoshi YOSHIDA**. [J. Jap. Soc. N. A., **38** (1926), 17-32, with fig. and tables.]— This is a preliminary report of the results of ventilation tests made on board three warships built in the Mitsubishi Dockyard and Engine Works at Nagasaki. The actual data of the tests are reported. T. M.

2. *On the Salvage Works of Sunken Battleships* (Japanese). **Jumpei FUKUI**. [J. Jap. Soc. N. A., **38** (1926), 65-74, with pl.]— A comparison is made on the method of salvaging battleships in different countries—Japan, Italy and Russia. The author criticizes each method from his vast personal experience and expresses his views. T. M.

3. *Stability of Thin Plates* (Japanese). **Katsutada SEZAWA**. [J. Jap. Soc. N. A., **38** (1926), 79-96, with fig.]— The stability of thin plates used in various parts of a ship's hull is studied mathematically and experimentally. The limit of the stability of a certain mode of the plates is considered as that of restitutive vibrations corresponding to that mode of stability; this consideration is a known principle of mechanics, but has not been much used in applied mechanics. The paper consists of twelve sections, of which the first gives the general principle while the remaining eleven deal with the stability of the various forms of plates, with special reference to that of long rectangular plates, of circular strips, of beam-plates and bracket-plates. They are all obtained by solving the differential equations of vibrations. Slight deviations from the mathematical theory have been found by model experiments made with celluloid plates. Author.

4. *On Frictional Resistance*. **Masami ONO**. [J. Jap. Soc. N. A., **39** (1926), 11-58, with fig. and tables.]— An attempt to investigate various mechanisms of fluid friction. In Part I an expression for the velocity distribution in the boundary layer derived from the consideration of the "eddy-viscosity" is given. The effect of the roughness of surface on the velocity distribution is also dealt with.

Part II deals with the problem of the resistance of flat plates. Most of the formulae hitherto proposed for the frictional resistance require the constants contained in them to be determined by experimental results. The formula arrived at by the author is no exception, but the physical nature of the constants (two in the present case) contained in it have been made clearer. The effect of the surface roughness is considered in this part. The law of similitude of very rough and imperfectly smooth surfaces are discussed.

In the last Part the application of the method of the boundary layer to a curved surface is discussed. The sudden fall of the resistance-coefficient of a sphere and of a circular cylinder finds its explanation for the first time and the profile drag of aerofoils and the frictional resistance of airship hulls have been calculated from the known values of velocity on the surface. In the Appendices some allied problems are dealt with.

Author.

**5. On the Failure of the Circumferential Claw-Bolts of the First Reduction Gear-Wheel in the Double Reduction Gear of the S.S. "Hakozaki Maru"** (Japanese). **Shinji MORISHITA**. [J. Jap. Soc. N. A., **39** (1926), 95-113, with fig., phot. and tables.]—The author describes the failure of circumferential claw-bolts, which occurred one after another during a voyage and the emergency measures he took as first engineer of the ship. He explains the results of the material tests of the bolts and the investigations of this failure which were done by the Mitsubishi Zosen Kaisha. He expresses his view on the probable cause of this failure. Author.

**6. On the Gyroscopic Vibration of Marine Steam Turbine Discs.** **Kyōji SUEHIRO**. [J. Jap. Soc. N. A., **39** (1926), 121-128, with fig.]—When a turbine steamer pitches or yaws, such a motion being that of precession with respect to the turbine discs, these are subjected to a gyroscopic force perpendicular to their plane. As this force is evidently distributed harmonically round the discs, and is fixed with respect to axes of reference fixed in the ship, the revolving discs are set to a transversal vibration having one nodal diameter, which is fixed with respect to the said axes of reference.

The author began with the solution of the equation of such vibrating motion without taking the effect of centrifugal stresses into consideration. Next, it was shown how a correction for the effect of the centrifugal stresses may be introduced.

The result obtained by the theoretical investigation was confirmed by a model experiment.

The phenomenon has so far escaped the notice of turbine engineers, but the author emphasizes the necessity of paying careful attention to it. Author.

**7. A Hauling-up Apparatus for Salvaging Wrecked Submarines** (Japanese). **Jumpei FUKUI**. [J. Jap. Soc. N. A., **39** (1926), 129-139, with fig. and pl.]—The apparatus has been invented to haul bodily a vessel as quickly as possible above water in order to rescue the crew of a sunken submarine. Every submarine is provided with a special fitting having a projection, to which a leading wire and a buoy are fitted. The wire and the buoy have a connection to a telephone buoy. When a vessel founders, the telephone buoy floats on the surface of sea carrying the wire with it, which is picked up. From one side of a salvage vessel a strong rope fitted with a catching gear at its end is let down, the picked up wire being made as a guide and is clutched automatically to the said fitting on the submarine. A tackle is joined to this rope and the fall is led over the salvage vessel to another submarine suspended on the other side which serves as a counter-weight.

On the completion of the preparatory work the hung submarine is made to sink by flooding. The weight of the suspended submarine and some additional pull given by winches makes it possible to haul the wrecked submarine to the surface of the water. Afterwards the sunken submarine is again raised above water by supplying compressed air to it. Author.

**8. Some Experiments made with Test Pieces with Holes in order to investigate the Relation existing between Deck Opening and the Stresses produced in its Neighbourhood** (Japanese). **Masuto YAMAGUCHI**. [J. Jap. Soc. N. A., **39** (1926), 149-165, with fig., phot. and tables.]—About 40 test pieces similar to the deck opening of a ship were prepared in order to study the breakdown of deck



platings by means of models having one or two holes. These test pieces were pulled by a testing machine along or obliquely to the centre line. The fracture occurred in some cases at corners and in the other between corners, and no distinct relation was found between the points of fracture and the direction of the pull, except for the fact that the lines of fracture appeared always at right angles to the longer edge of the test piece. When the fracture occurred at the corner, it was at the end of the rounded or doubling part, with one exception which occurred across a thin doubling (one-quarter the thickness of the deck plate). With respect to the deformation of the hole the breadth practically did not change, but the length became visibly longer. The strength of the test piece became approximately 3% greater than that of test pieces made from the same plate having the same effective area.

Author.

**9. *A New Method of Recording the Rolling and Pitching of Ships.***  
**Naoshi SATŌ.** [*"Zassan,"* Jap. Soc. N. A., **53** (1926), 1-6, with fig. and a table.]—To record the oscillation of ships, a photographic method is used.

Part I. Model experiment. The mechanical recording apparatus hitherto used has a defect in that it is influenced by the resistance offered to the oscillating part. The author tried an optical method to avoid such a defect. A fine mast is erected above the centre of gravity of the model and a camera is so placed that its optical axis is in the middle line plane of the model. When the model is set to rolling the mast is photographed intermittently, the camera being fed continuously. The curve of rolling can be obtained from the inclinations of mast photographed in the films.

Part II. Experiments in actual ships. In this case, too, the author adopted an optical method. A cinematographic camera is fixed horizontally on the deck of a ship and is directed longitudinally. The inclinations of the horizon shown in the film give the rolling angles of the ships, and the change of the mean heights of the same gives the pitching. As the present method is very reliable, it can be applied for checking the behaviour of recorders.

Author.

**10. *The Effective Wave-Slope in the Pitching Motion of Vessels***  
(Japanese). **Ryūtarō ASABA.** [Tech. Jour. Kyūshū Imp. Univ., I., **3** (1926), 111-120, with fig. and tables.]—In this paper the effect of the ratio of the length of a ship and of the waves and of the fineness of the water plane upon the effective wave-slope is investigated theoretically. The formula obtained by Captain A. Kriloff is used in calculating the pitching moment while the shape of the water line is assumed to be parabolic. An approximate method of calculating the correction term in Kriloff's formula is given in the appendix.

When the wave length is less than 60% of the ship length, the ratio of the maximum effective wave-slope to the maximum surface-slope is very small, say under 0.08 and is larger for vessels having fuller water planes. For longer waves, it increases rapidly and approaches to the unity, and the fineness of the water plane has little influence on it. The effective wave-slope is minimum when the ratios of the length of waves to the ship are about 0.6, 0.38, 0.27, etc.

Author.

**11. *On the Comparison between Shipbuilding Steel Materials*** (Japanese).  
**Shintarō SASAKI.** [J. Jap. Soc. N. A., **38** (1926), 165-200, with fig., phot. and tables.]

12. *On Marine Scotch Boilers* (Japanese). **Reiji SHIBATA**. [J. Jap. Soc. N. A., **39** (1926), 59-80, with fig.]

13. *A Marine Engineer's View of Diesel Engines* (Japanese). **Isaac OGATA**. [J. Jap. Soc. N. A., **39** (1926), 81-92, with tables.]

14. *On the Electrically-Propelled Steamer "Biyō Maru"* (Japanese). **Chōzō ONO** and **Tokuji ŌGA**. [J. Jap. Soc. N. A., **39** (1926), 109-141, with fig., pl. and tables.]

15. *On the Turning of Ships* (Japanese). **Tomoyoshi HAGI**. ["Zassan," Jap. Soc. N. A., **48** and **52** (1926), 1-4 and 1-6, with fig.]

16. *The Propelling Machinery of a Cargo Vessel and its Relation to the Hull Design*. **Chōzō ONO**. ["Zassan," Jap. Soc. N. A., **51** (1926), 1-4, with fig. and a table.]

17. *Application of Nomographic Calculation to the Design of Ships* (Japanese). **Shōgo NOMURA**. [Tech. Jour. Kyūshū Imp. Univ., **I**, **1** (1926), 27-30 with fig.]

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## AERONAUTICS (1—10).

1. *On the Mitsubishi 470 H. P. Aero-Engine* (Japanese). **Seiji OGAWA**. [J. Soc. Mech. Eng. Tokyo, XXIX., 105 (1926), 1-24, with fig. and tables.]—Report of a new twelve-cylinder four-crank aero 470 H. P. engine constructed by Mitsubishi Nainenki Kaisha. The engine is the most powerful one ever built in Japan, and successfully passed a fifty hour endurance test. The engine develops 470 H. P. at 1,601 r.p.m. of crank shaft during the test. K. K.

2. *Investigation of Altimeter, Part I, Analysis of Errors* (Japanese). **Kiyoshi TOMIDUKA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 18 (1926), 31-60, with fig.]—The paper contains the results of the test of three German altimeters. The nature and magnitude of drift and temperature errors are estimated, and the elements of hysteresis errors are analysed. Author.

3. *Nomographs for Change of State of Gases and the Power of Air-compressors* (Japanese). **Kiyoshi TOMIDUKA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 20 (1926), 147-146, with fig.]—Seven nomographs are worked out. The first four enables one to compute very easily relations between pressure-ratios, volume-ratios, and absolute temperature-ratios. The next two enable one to find the numerical value of  $\frac{n}{n-1} \left[ \left( \frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right]$  by a very simple process. In each case any value of  $n$  can be taken. The last one is used for finding the value of air density. Author.

4. *Aileron-Design* (Japanese). **Hidemasa KIMURA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 25 (1926), 421-438, with fig. and tables.]—A report of the investigations carried out on the ailerons of eleven captured German aeroplanes, from a structural point of view. K. K.

5. *Physiological States and Psychological Work at High Altitudes* (Japanese). **Matatarō MATSUMOTO, Kanichi TANAKA, and Iwao TERAZAWA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 25 (1926), 439-450, with tables.]—Report of the investigations as to the effect of high altitudes on the physiological states and mental work of men, conducted by the authors on Mt. Fuji from 15th to 26th, July, 1919.

The following items relating to ten men were observed at several stations at different heights above sea level. (1) Blood pressure (2) Pulse-rate and form of pulsation (3) Frequency of respiration (4) Constituents of the blood (5) Vital capacity (6) Chest circumference and its difference (7) Bodily temperature (8) Auditory threshold (9) Visual acuity.

K. K.

6. *A Hot-wire Air-flow-meter* (Japanese). **Masakiti ISHIKAWA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 26 (1926), 460-466, with fig.]—The

air-flow through a pipe is heated uniformly by electric current. The quantity of the flow is obtained if the heating energy and the temperature rise of the flow due to the heating are observed. The flow-meter here described is so constructed that a single reading of the voltage of the heating current suffices to measure the flow under all conditions, the temperature rise being adjusted so as to be constant. The method of calibration is also explained. Measurements are expected to be accurate within 1%. Author.

**7. On Air-Pressure Transformers** (Japanese). **Kiyosi TOMIDUKA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 27 (1926), 469-484, with fig.] — This is the first part of a paper concerning the new apparatus that resembles, in function, to the electric current transformer, and can be adopted as an aero-engine accessory. With this device one can obtain a comparatively large quantity of relatively low-pressure air from a small quantity of high-pressure air supply. The apparatus essentially is a single wheel turbine, which acts primarily as the impulse turbine, and acts secondarily as turbo-compressor. High-pressure air expands through the nozzle and impinges on the turbine, and goes to the delivery pipe mixed with air newly sucked by the turbo-compressor, thus the final delivery attaining the large quantity. Theoretical calculations for both air quantities, and for the temperature-relation are shown. The formula for determining the chief quantities of the apparatus is also given. Part 2, and part 3 of the paper follow. Author.

**8. Recent Developments in Aircraft Engines** (Japanese). **Masakiti ISHIKAWA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 27 (1926), 515-530, with fig.] — Requirements for aircraft engines are discussed under several headings. It is also explained with actual examples, to what the endeavours of engine makers are directed in improving their engines, and how much the requirements are fulfilled in recent engines. Author.

**9. Fuel Supply System for Aero-Engine Laboratory** (Japanese). **Kiyosi TOMIDUKA**, and **Dōtoku KOBAYASI**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 29 (1926), 569-572, with fig.] — A new type of gasoline feed system designed by the authors is described. In this system, the main tank is placed out of doors to eliminate risks of fire, and the fuel is fed by the action of compressed air that acts upon the level of the fuel. Air pressure can be regulated from the operator's stand. To this is added the gasoline measuring tank which is placed on a weighing machine, the level of fuel in this tank being limited by the float-valve. The air pressure is also applied to this tank and is regulated manually but very easily so as to obtain a constant head at the carburetor float-valve. A special differential manometer is added for this purpose. This system is especially suited to altitude laboratory service. Authors.

**10. Some Experiments concerning Altimeters** (Japanese). **Tatudirō SASAKI** and **Ikutarō HAGIWARA**. ["Zatsuroku" of Aeronaut. Research Inst. Tōkyō Imp. Univ., 29 (1926), 673-589, with fig. and tables.] — Owing to the necessity for increased accuracy in altimeters of recent years, many kinds of experiments have been carried out on them by several researchers, but the cold-test and vibration-test are still lacking. In this paper these two tests are described in some detail. Authors.



## TECHNOLOGY OF ORDNANCE (1—7).

1. *On the "Dévirage" Motion of the Turret-Mounting* (Japanese). **Tokizō KAWASE**. [J. Ord. & Exp., XIX., 3 (1926), 161-173, with fig. and a table.]—The author mathematically deals with the "dévirage" motion of the turret-mounting and calculates the force on the training rack, the frictional coefficient of the friction-discs, and other matters from an actual record of "dévirage" of a 36 cm. turret-mounting.

M. A.

2. *On the Motion of Side-loading Submerged Torpedo Tubes* (Japanese). **Tamotsu AOKI**. [J. Ord. & Exp., XIX., 4 (1926), 231-272, with fig.]—This paper consists of eleven chapters of which the first is introductory. In the second chapter a concise account is given of the construction of torpedo tubes and their operation. The remaining nine chapters relate to the motion of torpedo tubes, and the distributions of the pressures on the back surface of the piston. The equations of motion of the torpedo tubes are derived, but no numerical examples are given.

T. M.

3. *On the Design of the Starting and Stopping Mechanism of White-head Torpedoes* (Japanese). **Tamotsu AOKI**. [J. Ord. & Exp., XX., 1 (1926), 1-16, with fig. and tables.]—The author derives the formulae by which to determine the force necessary to raise the starting lever of a "group," and gives the resistance of water experienced by the water-tripper, and their applications. It is concluded that the former force amounts to 8.3-10 kg. when "slow turning" and 6.4-8.5 kg. when "no turning," and the latter resistance varies parabolically with the turning angle of the starting lever, having a maximum value at 70 gr. or so.

T. M.

4. *On the Velocity of the Striker of a Rifle* (Japanese). **Tamotsu AOKI** and **Shinji ICHINO**. [Bull. Military Arsenal, IV., 1 (1926), 1-11, with fig. and tables.]—First the author deduces the expression of the velocity of a striker in terms of the distance travelled by the striker, its mass, the stiffness and the mass of the spring, and the friction. Next he obtains the actual velocities experimented upon by photographing on a film revolving uniformly the motion of the striker. Comparing these to the theoretical values, he reaches the following conclusions in his case:—

- (1) The time of the movement of strikers is about  $5.6 \times 10^{-4}$  sec.
- (2) Striking energy at the primer is about 0.14 kg-m.
- (3) Friction which can be taken as nearly constant, is 0.3 kg.
- (4) Loss of kinetic energy due to friction is about 4% of the theoretical one.

T. M.

5. *Comparative Tests of the Detonating Power of Primers, Second Report* (Japanese). **Tsuneo NOHARA** and **Shūkichi ICHIKAWA**. [J. Ord. & Exp., XX., 1 (1926), 17-25, with tables.]

6. *On the Causes of the Detonation of Explosives* (Japanese). **Tsuneo NOHARA**. [J. Ord. & Exp., XX, 2 (1926), 76-78, with tables.]

7. *On the Increase of the Manufacturing Capacity of the Exercised Shells of a Field Gun* (Japanese). **Nobutake TAMURA** and **Masao MUKUMOTO**. [Bull. Military Arsenal, IV., 4 (1926), 287-304, with fig., pl. and tables.]

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## ELECTRICAL ENGINEERING (1—101).

1. *On the Relations between the Fundamental Wave-Emission, Anode and Grid-Currents of a Triode with respect to their Amplitudes and Phases* (Japanese). **Eijirō TAKAGISHI**. [J. I. E. E. Japan, **450** (1926), 29-52, with fig.]

—The fundamental dynamic wave characteristics of a triode are investigated experimentally. The writer then studied how to derive the dynamic characteristics of a triode from its static ones under any working conditions and explained a practical method, for doing so by making use of the triangular chart. These were confirmed by experiments.

Author.

2. *On the Production of Short Electric Waves* (Japanese). **Shintarō UDA**. [J. I. E. E. Japan, **450** (1926), 53-64, with fig.]—This is the second report of experiments

made by the same author in the Tōhōku Imperial University. He obtained with two valves the most stable and powerful oscillations by means of a suitable electromagnetic coupling, and succeeded in producing short electric waves—at different wave-lengths—of few metres. The wave-lengths were accurately measured by the methods of the Lecher wire system. The generators used by the author could maintain the amplitudes and frequencies of oscillations steady and constant during the experiment; wave-lengths are only determined by the circuit constants and do not depend upon the internal conditions of the electron tube generators. The author also obtained stable audible beats at 4.4 metre wave-length by means of two oscillators. Finally he pointed out that the hysteresis phenomena are observed in producing oscillations with positive and negative grid voltages and also that transient phenomena sometimes accompany the starting of oscillations at a certain small amount of filament current.

Author.

3. *On the Transient Phenomena of a Secondary Battery when the Charging Circuit is Opened* (Japanese). **Sakae MAKIO**. [J. I. E. E. Japan, **450**

(1926), 65-77, with fig.]—In the case of charging, the potential of storage batteries will recover its normal voltage within a short time after opening the charging circuit. The author investigated this phenomenon and discussed the influence of cadmium-ion upon it.

M. H.

4. *A Method of Calculation for Short Circuit Current of an Alternator* (Japanese). **Jōji SUGIURA**. [J. I. E. E. Japan, **450** (1926), 78-83, with fig.]—A

practical calculation for short circuit current of an alternator is shown. Assuming that magnetic circuits are all laminated, the armature current lags behind the voltage by  $90^\circ$  and armature leakage reactance is constant, the writer obtained (1) the duration of the transient phenomena and (2) the maximum possible armature current after taking into account the field leakage impedance.

Author.

5. *On the Loci of the Propagation-Constant and the Surge-Impedance* (Japanese). **Kanesaburō KUROKAWA**. [J. I. E. E. Japan, **450** (1926), 84-100, with fig.]

—When a vector terminal describes a certain locus on its plane, the square root value of

that vector will correspondingly also trace another. The latter may be called the square root or radical figure of the former. Thus, the radical figures of a straight line, a circle passing its origin, a circle in general position and a parabola having its axis on the abscissa are shown respectively to be a rectangular hyperbola, a lemniscate, a casinian curve or oval and a radical parabola, the last having been discovered by the writer.

The loci of square vectors of the propagation-constant or vector-attenuation and the vector-surge-impedance, when one of the line constants or the angular velocity of the current is varied, are easily seen to be either one of a straight line, of a circle or of a parabola. Thus, their radical vectors or the propagation-constant and the surge-impedance themselves trace one of the radical figures, mentioned above. Each case is discussed in detail.

As a numerical example, the loci for the standard telephone cable are traced, when the linear inductance, leakance or the angular velocity is varied. Author.

**6. On the Conditions for the Non-occurrence of Natural Oscillations in a System of Electric Circuits** (Japanese). **Takeji HOASHI**. [J. I. E. E. Japan, **450** (1926), 101-106.]—In the second term of Heaviside's expansion theorem which expresses the transient phenomena of an electrical system, each root,  $P_m$ , of  $Z(p)=0$ , represents the characteristics of the respective natural oscillation of that system. That is, the real part of  $P_m$  represents the damping of one of the natural oscillations in the system and the imaginary part of it represents the angular velocity of that oscillation.

In this paper, the writer discussed the sufficient conditions for all roots of  $Z(p)=0$  to be purely real. Author.

**7. Compensated A. C. Potentiometer and A. C. Currentometer** (Japanese). **Heiichi NUKIYAMA and Yasushi WATANABE**. [J. I. E. E. Japan, **451** (1926), 153-161, with fig.]—The present paper includes the following three topics:—

- (1) Some remarks on the compensation of the A. C. potentiometer,
- (2) A. C. Currentometer, a new method of measuring an alternating current in magnitude and phase,
- (3) Theory of the A. C. currentometer.

The first part gives some remarks on the A. C. potentiometer with special reference to its application to the measurement of a very high impedance. The effect to feeding-current due to the connection of the potentiometer is considered in detail. Then, a compensated potentiometer is proposed as an ideal arrangement to accomplish a compensation of a potential of one of its detecting terminals in order to measure any potential difference at a natural feeding condition.

A practical circuit arrangement is also given. In this case, it is important to fix the feeding-point at a suitable position, and to measure the potential difference of any point against this feeding-point.

In the second part, a new arrangement, which the writers suggest to call the A. C. Currentometer, is described. By means of this apparatus, we can measure accurately the current of an order of microampere. The current is measured directly in magnitude and phase without any impedance drop.

As an example, the input impedance of a triode valve measured by these two methods are compared.

In the last part the theory of the A. C. currentometer is treated, and some remarks of practical importance are given. Authors.



**8. On the Input Admittance of a Triode Valve** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **451** (1926), 162-178, with fig.] — The problem of finding the input admittance consists in determining the grid current which flows in the external input circuit as a result of the impressed input voltage. In the present paper the writer deals with its dependence upon the load in the plate circuit, representing the input admittance in a vector diagram. Subsequently the locus of the vector of the input admittance is considered. The locus is expressed by a circle-diagram, when the plate loading or the static coupling between the grid and the plate is varied. The position of the centre and the radius are given mathematically as a function of circuital constants as well as of valve constants. By means of an A.C. currentometer, the circle-diagram is experimentally obtained at  $\omega=5,000$ . Then, comparing the experimental and theoretical results, the writer comes to the conclusion that it is necessary, especially when the frequency is low, to take into consideration the conductance between the grid and the filament, even when the grid is negative. Moreover, the relation between the input admittance and the input voltage is considered. Some remarks relating to the input admittance are also given. Author.

**9. Wave-Form of Corona Current in Air and Solid Dielectrics** (Japanese). **Hideji YAGI** and **Kaneshirō UNNO**. [J. I. E. E. Japan, **452** (1926), 267-272, with fig.] — Tests on the corona are made with apparatuses of concentric cylinder type, the high voltage at 50 cycles per sec. being supplied from a 100,000 volt testing transformer.

The oscillograms of corona in air show that: (1) The crest of the current wave coincides in phase with that of the voltage wave, (2) With increasing corona current, the critical voltage (instantaneous value) becomes lower.

When solid dielectric (glass and paraffin) is made to surround the corona rod: (1) The crest of the current wave advances in phase with respect to the voltage wave, (2) The appearance in each cycle of the negative corona accompanies high frequency oscillations. Authors.

**10. On the Wireless Beam of Short Electric Waves, I.** **Shintarō UDA**. [J. I. E. E. Japan, **452** (1926), 273-283, with fig.] — This paper is the first report upon the experimental researches by the author on the wireless beam of short electric waves of a few metres. The method of generating continuous waves of ultra radio frequencies is the same as already reported by the same author (J. I. E. E. Japan, **450** (1926), 53-64.). The electric intensities of the field due to the oscillator itself (without antennae and reflectors) are observed at first in various directions around it. In this case the plate and grid coils in the oscillation circuit form the radiators of short radio waves. The distribution of electric field intensities in the horizontal plane containing the oscillator is not uniform in all directions and the maximum values of their vertical components exist in the directions of the plane of the plate and grid coils, but in these directions the horizontal component is negligibly small. On the other hand, in the directions normal to the plane of the plate and grid coils, the vertical component of the field intensities almost vanishes while the horizontal components show maxima in these directions, although their values are too small to compare, at the same operating conditions, with those of the vertical components in the former case. As the antenna or the radiator, a single brass rod of 2.2 metres in half wave length is used and its effect upon the field-intensities and distribution (around the oscillator) is observed, when the antenna is placed in various positions near the oscillator.

It is also stated that the unidirectional field can be easily obtained by the combination of several antennae or radiators. For this purpose, a simple device of three rod antennae attached to the transmitting apparatus in a suitable arrangement is proposed and the results of experimental studies on this method are shown. Author.

11. *On the Transient M. M. F. in the Commutating-Zone of Synchronous Converters* (Japanese). Kikujirō ŌSUMI. [J. I. E. E. Japan, 452 (1926), 283-298, with fig.]—The author describes a method of obtaining the time and space distribution of transient magnetomotive force in the commutating-zone of synchronous converters, when a sudden change of load occurs. The transient values of direct and alternating current components in the armature are calculated, taking all of the following factors into account; the synchronous and asynchronous torques, the inertia of rotating parts, the inductance of D. C. circuit, the effect of speed on the output of the machine, etc. The direct and alternating current magnetomotive forces are then calculated separately, by the formula developed by Prof. T. Yamamoto, and the resultant of these two is taken as the actual M. M. F. on the surface of the armature. As a numerical example, this method is applied to the calculation of transient M. M. F. of a 1,000 K. W., 600 volt, 6-phase shunt-wound converter, under the sudden changes of 500% load. Author.

12. *Experimental Study of Input Admittance of Triode Valve at Radio-Frequency and a Method for Measuring Radio-Frequency Valve Constants* (Japanese). Yasushi WATANABE. [J. I. E. E. Japan, 452 (1926), 299-310, with fig.]—A new dynamic method of determining the valve constants at radio-frequency is dealt with. The principle of the new method consists in determining the variation of the input admittance, which depends upon the valve constants. In a paper "On the Input Admittance of a Triode Valve" (J. I. E. E. Japan, 451 (1926), 162-178.) the writer showed that the circle-diagram of the input admittance depended upon the circuit constants as well as the valve constants. Consequently it enables us to determine the valve constants from any measured results corresponding to the circle-diagram. Some examples of determination at a radio-frequency of 100,000 cycles per second are described, and it is concluded that the valve constants are literally constants independent of the frequency within the range of the writer's experiments. Some experimental results of the input admittance at radio-frequency are also described. Author.

13. *On the Action of Parallel Plate Condensers under Very High Frequencies* (Japanese). Takeji HOASHI. [J. I. E. E. Japan, 452 (1926), 311-318.]—The author investigates mathematically the action of parallel plate condensers under very high frequencies. The result obtained tells that the equivalent capacitance at very high frequencies is independent of its specific capacitance at low frequencies and inversely proportional to the specific resistance of the condenser plates and the impressed frequency. For ordinary condensers it is not necessary to consider such an effect of the frequency on the capacitance unless the frequency is as high as some hundred million cycles per second. Author.

14. *On the Eddy Current in Transformer Oil* (Japanese). Shigeo MOCHIZUKI. [J. I. E. E. Japan, 452 (1926), 319-324, with fig.]—The motion of the

microscopic substances in transformer oil is investigated in this case:—

(1) With needle and plane electrodes.

When the critical voltage is applied between the electrodes at a large spacing, the microscopic substances migrate towards the needle electrode through the dielectric field only. Above the critical voltage, however, the circulation towards the plane electrode appears through the ion pressure, as the oil next to the needle electrode is very highly stressed.

For electrodes at short spacings, the migration towards the needle electrode tends to disappear, because the attractive force due to the dielectric field, a little apart from the centre line of the electrodes, more rapidly decreases at a short spacing as compared with that at a large spacing.

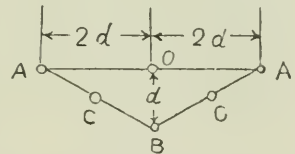
(2) With sphere electrodes.

The macroscopic substances migrate towards the comparatively large fibrous materials partly bridged across the gap, therefore the sense of the eddy current in this case depends on the dielectric field only.

(3) The wave form of the applied voltage is explained by Lichtenberg's figure on the rotating film. Author.

**15. Method for Measurement of High-Resistance by Means of the Lichtenberg Figure** (Japanese). Matsunosuke IWATAKE. [J. I. E. E. Japan, 452 (1926), 325-327, with fig.]—The shift from the half-way position of the meeting line of the two unequal Lichtenberg figures due to a known high-resistance in the path to one electrode is utilized to measure an unknown high-resistance. Author.

**16. On the Wireless Beam of Short Electric Waves, II** (Japanese). Shintarō UDA. [J. I. E. E. Japan, 453 (1926), 335-351, with fig.]—In order to increase the radiative power in a desired direction, and to maintain the directive property of an electric field, metallic rods of finite length are used as reflectors and the experiments in connection with this line of investigation are made. A single reflector rod placed a quarter wave behind a radiating antenna is sufficient to cause directive radiation of radio-waves. When the distance between the antenna and the reflector is equal to half a wave length, the electric waves are radiated chiefly in the direction normal to the line joining the antenna and the reflector. If this distance is equal to three quarters wave length, maximum radiations exist in three directions. If two reflector rods are vertically erected at the distance of half a wave, or a quarter wave length from the antenna, one being on the left and the other on the right side of it, the wave energy is projected chiefly in the forward and the backward directions of the antenna, but the former case gives better directivity than the latter. In the author's experiments, a 4.4 metre wave length is employed and the lengths of antenna and reflector-rods are all equal to half a wave length, i.e. 220 cm. The intensity is measured with a receiving system comprising a crystal detector and a micro-ammeter. The simplest and comparatively effective reflector formed by the author has the following construction. A reflector rod (B) is placed a quarter wave behind the antenna (O) and two more reflectors (A A), one being on the left and the other on the right side of it, are placed a half-wave distant from the antenna. These three rods form a tri-antennary reflecting system which the author calls a fundamental "Trigonal reflector." Two more reflector rods





(C C) shown in the figure are not as efficient as a reflector as (A) and (B), but their existence enables closer screening of waves in the backward direction, and when this reflector system is employed in a receiving station, they are specially effective to eliminate external disturbances from behind. Combined with these screening rods, the trigonal reflector is now formed of five rods. The positions of the screening rods are midway between (A) and (B), and a slight variation of their positions is practically ineffectual. When the trigonal reflector is employed in a receiving station, it is called a "Trigonal collector." In order to obtain sharper directivity, more reflector rods are required, in addition to the fundamental trigonal reflector. Further researches with respect to this point will be reported later on.

Author.

**17. On the Protection of Transformer Coils** (Japanese). **Risaburō TORIKAI**. [J. I. E. E. Japan, **453** (1926), 352-361, with fig.]—An abnormal potential gradient which threatens the layer insulation of transformer coils, can be removed by shunting each section of the coil with graded capacities (See J. I. E. E. Japan, **303** (1921), 740-750.). The author made mathematical investigations about the mode of the gradation of the capacity and obtained

$$C_s = \delta C \left( \frac{1}{2} y^2 + \text{constant} \right),$$

where

$y$  = distance of the point, considered, from the end surface of the bobbin of the coil, containing the electrical neutral point,

$\delta$  = length of the wire of coil per unit length of bobbin,

$C$  = capacity of the wire of coil to ground, per unit length.

If we use the shunting capacity given above, no danger arises in the transformer coil.

Author.

**18. On the Methods of Measuring Phase-Angle by means of a Triode** (Japanese). **Takabumi KUMAZAWA**. [J. I. E. E. Japan, **453** (1926), 362-396, with fig.]—Four methods are proposed to measure a phase-angle with a single triode. These methods were studied experimentally and theoretically. (1) A triode is used like a mere potentiometer. Two alternating E. M. Fs. are impressed to anode and grid, and by finding the minimum anode or emission current, one may join any two E. M. Fs. in opposite phase. Therefore, by means of some phase-shifting device, two E. M. Fs. with unknown phase-angle are joined in opposite phase to the shifting E. M. Fs. of the device one by one, and thus, the unknown phase-angle is measured. (2) Two alternating E. M. Fs. having a phase difference  $\alpha$  are impressed to anode and grid. In this case it was found that, when  $\alpha$  is a constant, the anode E. M. F. and grid E. M. F. which gives the minimum anode current, satisfy a linear equation. Therefore, if the grid E. M. F. that gives the minimum anode current at a constant anode E. M. F. is given,  $\alpha$  can be found. (3) Two alternating E. M. Fs. are impressed to anode and grid. If there is no effect in the anode (and emission) current by changing the sign of the grid E. M. F., these two E. M. Fs. must be in quadrature. Therefore, one may join two E. M. Fs. in quadrature, instead of in opposite phase as in the first method. Thus any phase-angle can be measured as in the first method. (4) The minimum value of the emission current is made use of. This latter holds good for the wider range of  $\alpha$  than the former. If  $\alpha$  be kept constant, the anode E. M. F. is proportional to the grid E. M. F., when these E. M. Fs. give the minimum emission current. The following simple relation is found, when the emission current is a minimum value:—



$$\mu E_g + E_p \cos \alpha = 0$$

where,  $E_p$ =maximum value of grid E. M. F.,  $E_p$ =maximum value of anode E. M. F.,  $E_g$ =maximum value of anode E. M. F., and  $\mu$ =amplification constant. Author.

**19. Supplement to "On the Input Admittance" with reference to the Voltage-Amplification Ratio** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, **453** (1926), 397-405, with fig.]—The following relation exists between the input admittance,  $\dot{Y}_i$  and the voltage-amplification ratio,  $\dot{K}$  of the thermionic amplifier:—

$$j \omega C_2 \dot{K} = \dot{Y}_i - (\dot{Y}_i)_0$$

where  $(\dot{Y}_i)_0$  is the input admittance in the case of zero plate impedance.

In the paper "On the Input Admittance," published before by the same author, (J. I. E. E. Japan, **451** (1926), 162-178.), the circle-diagram of the input admittance was treated mathematically and also experiments were described in verification.

In this paper, as supplementary to the previous one, the circle-diagrams of the voltage-amplification ratio for various cases of plate-loading are considered, and experiments are made at 100,000 cycles by means of the C. R. type A. C. potentiometer. Author.

**20. On a Newly Designed Potentiometer** (Japanese). **Masamiti SASE**. [J. I. E. E. Japan, **454** (1926), 454-458, with fig.]—The principle and some merits of a new potentiometer, which has two dials and a one-round slide wire resistance in its measuring part, are briefly described.

As for the advantageous properties of this instrument, the following three points are mentioned:—(1) The total resistance is low; (2) The resistance of the second dial is of such a high value that the effect of contact-resistance may be neglected; (3) The resistance of the slide wire is low, so that it can endure long and frequent use. The writer recommends the convenience of this instrument for general scientific investigations and also for technical purposes. Author.

**21. The Surface of Metal and Semi-Conductors** (Japanese). **Genki SADAKEYO**. [J. I. E. E. Japan, **454** (1926), 459-475, with fig.]—The resistance of the semi-conductors is mostly characterized by their contacts with electrodes, and the conditions of these contacts are chiefly effected by moisture and electrical and mechanical pressure.

The charging current of the insulator is generally observed and considered as decreasing exponentially with the time of voltage application. Using paper as the semi-conductor, there are in many cases some irregular changes of currents.

If a metal electrode is used, as the positive, to flow electric current through the semi-conductor, there are very fine particles of that metal, migrating through the medium; these fine particles may be considered as charged or ionized molecules or atoms.

The author discusses these phenomena and expresses his view as to their causes in this paper, and also proposes his new definition of ionization. Author.

**22. On Time-Lag Measurement of the Spark by Rotating Film** (Japanese). **Matsunosuke IWATAKE**. [J. I. E. E. Japan, **454** (1926), 476-481, with fig.]—The author utilized the "rotating film method" to measure the time-lag of the order

of  $10^{-4}$ – $10^{-5}$  second. The results show that, for equal gap-length, the time-lag of a needle-gap in the air is shorter than that of a sphere-gap under constant surge voltage.

M. H.

**23. Experimental Study on the Natural Wave Lengths of Pancake Coils** (Japanese). **Isamu YAMAMOTO**. [J. I. E. E. Japan, **454** (1926), 482–489, with fig.]—The present paper is the report of the experimental results on the natural oscillation wave length of the various kinds of pancake coils wound on square frames. It is shown that the ratio of the natural wave length to the total length of wire is closely determined only by the ratio of the winding width to the mean diameter of the coil.

From the measured value of the natural wave length and the self-inductance at audio-frequencies, the equivalent self-capacity was calculated.

The natural wave length was measured under three different conditions, i.e., (1) both ends insulated, (2) outer-end earthed and (3) inner-end earthed, and the results are shown in curves.

Author.

**24. Thermionic Effects caused by Aluminium and Magnesium** (Japanese). **Kinjirō OKABE**. [J. I. E. E. Japan, **454** (1926), 490–498, with fig.]—This paper shows the thermionic effects caused by aluminium and magnesium on commercial tungsten filaments. The electron emission from the surface of the filaments was increased considerably by the impacts of aluminium ions or magnesium ions. The nature of such filaments was studied carefully by measuring the rate of activation, the thermionic emission and the secondary electron emission from the surface of the filaments.

The filaments which have never been heated to a very high temperature during the various treatments have an extraordinarily high value in the rate of activation, and the relations between the voltage and the secondary electron current from the surface are quite abnormal. It is proposed here that aluminium oxide and magnesium oxide may exist on the surface in a special state with the atoms of rare metals. This state is named “A-state.”

Another state may be obtained by heating the filaments to a very high temperature. In this state, the condition of the surface is similar to those of the thoriated tungsten filaments. This state is named “B-state.”

The spectrum analysis of the commercial filaments which were employed in this study showed the existence of Th, Zr and a trace of Ce.

No distinct difference was recognized in the secondary electron emission curves, which were obtained from the activated filament and the deactivated one.

Author.

**25. Some Notes on the Characteristics of the Transformer Group in Extended-Delta Connection** (Japanese). **Matsujirō ŌYAMA** and **Setsuo FUKUDA**. [J. I. E. E. Japan, **454** (1926), 499–504, with fig.]—In extended-delta connection of single phase transformers, we can put simultaneous loads on two three-phase terminals of different voltage. The relation and limit of these loads for the safe operation of transformers are discussed, and a few examples are calculated and shown by curves. Attention is also drawn to the fact that this connection is superior on account of its high permissible total Kva. output to other connections, producing two different voltage circuits.

Authors.

**26. Stray Load Loss in Transformers.** **Sadaji MOMOTA**. [J. I. E. E. Japan, **454** (1926), 505–580, with fig.]—In the first part it is pointed out here that

the energy loss, caused by the alternating magnetic leakage flux in the tank plates, may reach an appreciable amount in the core-type transformers of high voltage and large output.

In the second part the distribution and the method of obtaining the total quantity of the alternating magnetic flux in a steel plate are described, and the permeability-ratio curves, which are useful in calculating the total flux, are given. The formulae of the eddy current loss, and of the hysteresis loss, and the loss-factor curves to be used in the calculation of these losses are obtained. The alternating magnetic flux can hardly penetrate into the interior of the steel plate, and consequently the iron loss is constant in steel plates exceeding a certain thickness for a given surface induction and permeability.

Energy losses in steel plates of various thicknesses are calculated for various surface inductions by the preceding formulae and the results are given as the flux-loss curves. The losses thus calculated are compared with the losses obtained by measuring the losses of the steel-plate cores prepared for the purpose.

In the third part the formula for calculating the leakage flux of transformers is given; and the experiments for the distribution of the leakage flux at outside of the windings, and the method of determining the flux passing through the tank plate, and also of determining the stray load loss caused by the flux in the transformer tank are described. The experimental results are given to verify the applicability of these calculations.

Calculation of the stray load loss per unit area of the tank plate ranging in wide extent is made and the formulae, applicable for the single phase core-type transformer of high voltage and large output, are deduced.

In the last part the author's method of eliminating the stray load loss by using the magnetic shield made of steel sheets is described accompanied by experimental data.

Author.

**27. *On the Acoustic Impedance at the Sending-End of an Exponential Horn of Finite Length*** (Japanese). **Katsuichirō KOBAYASHI.** [J. I. E. E. Japan, **455** (1926), 601-611, with fig.]—The author derived a formula for the acoustic impedance-density at the sending-end of an exponential horn of finite length from the equation of velocity potential, given by A.G. Webster in 1919, and calculated this value assuming that the air membrane at the open end has an infinite rigid flange, and compared this calculated value with the value obtained experimentally by measurement of the motional impedance of a telephone receiver, coupled with an exponential horn.

M. H.

**28. *The Transient Phenomena due to the Sudden Change of Circuit Constants*** (Japanese). **Takeji HOASHI.** [J. I. E. E. Japan, **455** (1926), 622-631, with fig.]—Heaviside's expansion theorem employed for the calculation of transient phenomena of an electrical system when the E.M.F. suddenly changed, is also applicable to the calculation of the transient phenomena when the circuit constants are changed suddenly.

The present writer shows a few simple examples for the calculation of such cases.

Author.

**29. *On the Input Admittance at High Frequency*** (Japanese). **Yasusi WATANABE.** [J. I. E. E. Japan, **455** (1926), 632-638, with fig.]—The present report is a supplement to the paper "Experimental Studies of the Input Admittance at High

Frequency," previously published by the same author (J. I. E. E. Japan, **452** (1926), 299-310.). The input admittance of a triode valve at high frequency is measured directly by means of C. R. type potentiometer. One example of experimentally obtained circle-diagrams of the input admittance is given for the verification of the author's theoretical study, the frequency being 100,000 cycles per sec.

One of neutralizing methods is discussed, in which the capacitive coupling between the plate and the grid is compensated by the inductance, connected in parallel with the plate-grid capacity. The circle-diagram of input admittance becomes less, the finer the compensation is adjusted.

In the latter, the value of resistance of the neutralizing coil, which is required for effective neutralization, is considered. Author.

**30. On the Relation between Short Wave Lengths and Possible Communication-Hours together with the Communication-Distance** (Japanese). Takashi ONO, Toyokichi NAKAGAMI and Chūhei ANAZAWA. [J. I. E. E. Japan, **456** (1926), 695-711, with fig.]—The authors made long-distance communication with different short wave lengths for one year to find out the relation between the wave lengths and possible communication-hours, as well as the relation between the wave lengths and the communication-distances. The general descriptions of the long-distance communication on short waves, and the test results for one year are reported in this paper.

The conclusions arrived at by the experiments are as follows:—(1) The short wave of about 24 metres is critical. (2) Short waves having the wave length of 25 metres or more are best utilized for night long-distance communication. (3) Short waves having the wave length of 22 metres or less are good for daylight long-distance communication. (4) It is ascertained that the phenomena of the skipped distance exists in the short wave transmission, especially for the short wave below 20 metres. Authors.

**31. On the Wireless Beam of Short Electric Waves, III** (Japanese). Shintarō UDA. [J. I. E. E. Japan, **456** (1926), 712-724, with fig.]—The present paper describes further experiments in directional radio-transmission on a wave length of 4.4 metres. According to the author's experience, a parabolic reflector is not necessary. A reflector consisting of vertical metallic rods arranged along a polygonal base line drawn on the ground is equally effective. Each of these rods is tuned to a half-wave length (2.2 m.) and spaced 1.1 m. apart.

The effects of varying the number of the reflector rods and of varying the aperture of the reflector were experimentally studied. Some experiments were also made to examine the effects of detuning the reflector rods. Good directional characteristic could be obtained when 19 reflector rods were used and the aperture of the reflector was nearly equal to 2.7 wave length. The radiated power was almost confined to an angle of 30 degrees. The author calls the reflecting system above described a "Polygonal reflector." When the polygonal reflector is employed at a receiving station, it is called a "Polygonal collector."

The field due to a parabolic reflector is also determined under the same conditions as for the polygonal reflector. Nineteen reflector rods were erected along a parabolic curve with intervals equal to 1.1 m. and the aperture of the reflector is made equal to 2.7 wave length. The radiation polar curves for both the parabolic and the polygonal reflectors show that these reflectors give directional characteristics of nearly equal sharpness.



The author also describes various types of directive antennae, such as "L type," "inverted L type," "U type," "rectangular type" and etc.; for all of which field measurements were carried out.

Measurements of received currents were made with a receiving apparatus comprising a crystal detector and a micro-ammeter. It has been very carefully ascertained that this crystal system gave the most consistent results throughout the long time of experiments.

Author.

**32 On a New Type of Precipitation and its Principle** (Japanese). **Tamotsu UEMOTO**. [J. I. E. E. Japan, 456 (1926), 725-733, with fig.]—The writer proposes a new treater of precipitation dependent upon the so-called dependent discharge, and elucidates its theory. This treater invented by the writer has two distinguished merits; that is, (1) it lowers electrode voltage; (2) it needs no rectifying apparatus. The writer mainly explains this phenomenon of electric precipitation from the standpoint of the "ionisation by collision" theory. By means of this explanation we can more easily understand such an induction phenomena as the surface-charge, the residual charge and the breakdown of insulators. Moreover for the sake of good insulation, it can be justifiably stated that we must be careful not only with regard to the insulating material itself but also as to the circumstances of surrounding gases and liquids. As to the precipitation, fume particles are attracted by the resultant of the attracting and repulsing forces between their surface-charges and the electrode potential. Therefore when the direction of this resultant force, electric wind and gas blowing are all coincident, it operates most effectively.

Author.

**33. On the Design of an Inductance Coil for Audio-Frequencies which has an Iron-Core with Air-Gap** (Japanese). **Heiichi NUKIYAMA** and **Kenzō NAGAI**, [J. I. E. E. Japan, 456 (1926), 734-741, with fig.]—In practice, it is usual for the inductance elements for audio-frequencies to employ iron-cored inductances which have an air-gap in order to avoid bulky dimensions and to make the ratios of effective resistances to their reactances as small as possible. In the present paper, the authors have theoretically obtained the length of an air-gap by the help of complex permeability with a few assumptions, and some relations which are necessary for the design of the iron-cored inductance, taking the leakage into account, have been deduced. The result of an experimental test is described to ascertain the accuracy of the theory.

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Authors.

**34. Surface-Creepage and High-Voltage Testing** (Japanese). **Takeshi NISHI** and **Keizō IKEDA**. [J. I. E. E. Japan, 457 (1926), 853-871, with fig.]—In the previous study of surface-creepage in alternating fields, ("Surface-Creepage and High-Voltage Insulation," J. A. I. E. E. Nov. 1920, pp. 949-959.), this phenomenon was found to be associated with the accumulation of a charge on the surface of dielectrics near the electrodes. During every half-cycle of alternating E. M. F., the residual charge accumulated during the preceding half-cycle is neutralised and a fresh charge of opposite sign is accumulated, the latter being neutralised again in the following half-cycle. Such a process goes on repeatedly so far long as the alternating field is held high enough to ionize the air near the electrodes.

The neutralization of the residual charge produces in the circuit damped oscillations of

very complicated nature. The maximum value of the current of such oscillation was found to be unexpectedly high, though the effective value is of the order of some hundredths of the maximum, probably due to the considerable damping in the oscillation circuits. The frequency of such oscillation was found to lie within the range of radio-frequency, though it was impossible to determine it definitely. Another peculiar feature of the damped oscillations is their unidirectional property, i.e. such oscillations are produced only when the corona-starting electrode is in a negative half-cycle.

In high voltage testing, if a surface-corona is started anywhere in the circuit, the high-frequency damped oscillation is superimposed on the alternating E. M. F. of power-frequency, it follows that:—

- (1) In the pressure test or in the dielectric-strength test, the insulating materials are liable to be over-stressed.
- (2) A sphere-gap for voltage measurement would discharge at apparently lower voltage.
- (3) The flash-over value of insulators, bushings, etc. would be indefinite in flash-over test.

Authors.

**35. On Electric Butt-Welding** (Japanese) **Takeshi OKAMOTO.** [J. I. E. E. Japan, **457** (1926), 885-898, with fig.]—Oscillograms are taken to show the amplitudes of the welding current and the voltage across the butt joint and also between the clamping block and bar. From these it is ascertained that the voltage across the joint is comparatively small and its initial value is usually less than one volt and even this decreases fairly rapidly owing to the gradual melting of the joint surface; while the voltage between the block and the bar is not so small and remains almost constant throughout the welding time and moreover appears on both sides of the joint. The value of this voltage depends largely on the condition of the surface of the bar, which is more or less covered with rust. The rusty surface makes the power loss between the block and the bar large, and renders the welding time long and irregular. As the voltage across the joint is comparatively small and decreases rapidly as above mentioned, the heat generated at the joint is not so large as might be expected; the heat quantity necessary for raising the temperature and melting the part adjacent to the joint which is rather produced in the metallic part itself owing to the increased resistivity of the metal, thus hastens to raise the temperature. From this it is concluded that the metal with a smaller resistivity and temperature coefficient is more difficult to weld. For example, copper bars are more difficult to weld than steel bars.

Bars of different diameters were welded with various powers and the corresponding welding times were measured and these relations between the power and time for each diameter are shown by curves, which resemble hyperbolas but gradually deviate from them upwards for smaller power and larger time. This fact shows that the welding with the smaller power requires greater energy and time. The tensile test was made on these welded bars and the result shows that the welds made with smaller power, i.e., with larger time are smaller in their tensile strength, although this tendency is less remarkable for bars of larger diameters. In either case we must make the welding time as small as possible. The effect of the spring pressure which is axially applied to the bar was tested. Bars were welded under various pressures, but with a constant power, and the result of this test is that the welding time is almost independent of the pressure and remains constant, but the tensile strength generally increases with the pressure. The joint is liable to be oxidized and this the more remarkable the longer the welding time and the less the spring pressure.

In order to be able to investigate the physical properties of the welds the knowledge of the maximum temperature along the bar and also the manner of the variation of the temperature is necessary and these are calculated by means of differential equations containing as many factors as possible, such as the heat transmission from the surface, the temperature coefficient of the resistivity and the heat generated at the joint etc., and these results obtained shown by curves. Author.

**36. On the Amplification of Ultra Short Waves by Thermionic Tube** (Japanese). **Hiroshi ANDŌ**. [J. I. E. E. Japan, 457 (1926), 899-907, with fig.]—The difficulties met in amplifying the ultra short waves are due to the inter-electrode capacities of the vacuum tubes. The author proposes a new method, somewhat similar to the modified neutrodyne system adopted for ordinary radio waves, in which effects of the inter-electrode capacity are neutralized by means of suitable balancing condensers. M. H.

**37. Design for Wave-Filter for Absorption of Irregularities of Direct Current Pressure Wave and Application of Aluminium Cell Condenser** (Japanese). **Tatsuo ISHIYAMA**. [J. I. E. E. Japan, 457 (1926), 908-935, with fig.]—The author has investigated analytically the properties of wave-filters of different kind and the method of preliminary design of the wave-filter, which is effective in protecting the direct disturbances to acoustic instruments from irregularities of pressure waves of D. C. generators to be used for the plate or filament-circuit of vacuum tubes in wireless communication and for the power source of automatic or common battery telephone systems. He found that an aluminium cell condenser can best be applied as a shunt condenser for such wave-filters. He also deduced a simple formula for the determination of the above wave-filters and explained the test results of wave-filters so designed by means of oscillograms. Author.

**38. On Lichtenberg's Figure of the Damped Oscillatory Discharge obtained by using the Rotary Film** (Japanese). **Shigeo MOCHIZUKI**. [J. I. E. E. Japan, 457 (1926), 936-944, with fig.]—Lichtenberg's figure produced by the damped oscillatory discharge is investigated, by arranging the electrode so as to act on the rotary sensitive photographic film, and the following facts are observed:—

I. Case with needle electrode placed on the rotary drum acting as an another electrode. (1) When the first half-wave is positive, the negative figure of the next half-wave loses its characteristic form and creeps over the same path as the previous positive one. (2) When the first half-wave is negative, the positive figure of the next half-wave maintains its characteristic form, but its path is not straight and proceeds tangentially near the extremity of the previous negative charge. (3) The ratio of the radius of the positive and negative figure of the first half-wave, is far greater than that of the next half-wave. (4) Connecting the two electrodes placed on the rotary film to lead wires having different inductance, the figure produced by the electrode with the greater inductance is larger than that produced by the electrode with the smaller one.

II. Case with the needle electrodes placed on the opposite sides of a rotary insulator disc. While the discharge is in the state of pole-brush, the positive figure obtained on one surface has longer creeping distance, compared with the negative one on the opposite surface, but the positive figure in the state of surface-spark-corona has the same creeping



distance as the negative one, and the discharges of both sides seem to restrain each other.

Examining the spark by means of a rotating mirror, the lowest frequency of damped oscillatory discharge obtained in these arrangement was ascertained to be the order to about  $1.1 \times 10^5$  cycles per sec.

Author.

**39. A Method of Obtaining the Braun Tube Figures in Rectangular Co-ordinates** (Japanese). **Isamu YAMAMOTO** and **Kiyoshi MORITA**. [J. I. E. E. Japan, 457 (1926), 945-959, with fig.]—The writers tried to employ the secondary induced voltage of a small transformer which is excited by the full-wave rectified current obtained by two kenotrons as the time-axis in the rectangular co-ordinates of the Braun tube figures. This secondary voltage was applied between one pair of electrode plates in a Braun tube and the voltage under test between another pair of plates, and when the fundamental frequency of the latter was an even multiple of that of the time-axis voltage, stationary figures were obtained in rectangular co-ordinates. Ideal time-axis voltage can be obtained when the primary rectified current has a parabolic wave form and the transformer has the ideal characteristics, but these conditions are not satisfied exactly in the actual case. For practical purpose, the wave form can be seen without appreciable error, taking a portion of the steady figure which is superimposed on the linear part of the time-axis voltage. In the present paper, the influences of the circuit constants upon the wave form of the secondary induced saw-teeth shaped voltage were first investigated by ordinary Braun tube figures, and then the wave form of microphone hammer, multi-vibrator and the damped oscillation in a triode circuit, were observed by the new method in rectangular co-ordinates.

Authors.

**40. A Study of the Acoustic Transformer By Means of Motional Impedance** (Japanese). **Heiichi NUKIYAMA** and **Katsuichirō KOBAYASHI**. [J. I. E. E. Japan, 457 (1926), 960-978, with fig.]—The theory of the acoustic transformer and a moving-coil type telephone receiver are described. Experiments were carried out on an acoustic transformer loaded by an orifice and coupled with a moving-coil type telephone receiver were measured by changing the volume of the acoustic transformer and the load. By the determination of the constants of the acoustic transformer in every case, by analysing the total mechanical impedance of the vibrating system obtained by measuring the motional impedances, the theory of the acoustic transformer was confirmed to be applicable to any load conditions.

Authors.

**41. On the Impedance Loci for Forced Damped Oscillations in Simple Series Circuits.** **Kanesaburō KUROKAWA**. [J. I. E. E. Japan, 457 (1926), 979-997, with fig.]—The current and displacement impedance graphs as well as those of admittances of simple series circuits of two and three elements are shown when one component of the hyperbolic complex angular velocity  $-a+j\omega$  is varied. Straight lines, circles, parabolas, inverse parabolas, circular cubics and inverse circular cubics appear as such locus graphs. Angular velocities of natural decays or oscillations are also discussed in these graphs.

A correction of an oscillographic record of damped oscillation is explained as an application of such locus curves. The transients, which take place when we impress an oscillating emf. gradually increasing to a L-R circuit, are also appended.

Author.



**42. Test of Radio-Frequency Amplifiers** (Japanese). **Shigetarō CHIBA** and **Shigeo KITTA**. [J. I. E. E. Japan, **458** (1926), 1003-1016, with fig.]—The present paper is a resumé of the test results obtained by the authors for the various type of high frequency amplifiers. For the wave length longer than 3,000 metres, the selective or the non-selective character may be obtained at will with the suitable design of amplifiers. By the use of audio-transformer sheets which form the closed magnetic path for the auto-transformer, a very good character can be given for the non-selective auto-transformer amplifiers. The amplifiers designed give practically constant amplification for wave lengths from 5,000 m. to 25,000 m. or from 3,000 m. to 10,000 m. It is shown that audio-transformer sheets may be also employed for the non-selective type amplifiers.

For shorter wave lengths, the non-selective type amplifiers must be abandoned since they are not efficient enough. To increase the amplification per stage, one of the following methods must be employed. (a) The coil of low-loss type must be employed. (b) Care must be taken to reduce the effect of the capacities included parallelly with the plate impedance. (c) It is sometimes necessary to reduce the effective resistance in the plate tuned circuit of the initial stage amplifier by feeding back the amplified voltage into the input side of this initial stage.

Typical examples obtained with reaction for the resistance and the transformer amplifiers are given. Some practical remarks are also given, which may be useful to obtain the stable working and the maximum amplification for the predetermined value of the wave length.

Authors.

**43. Performance of Multi-Stage Amplifiers** (Japanese). **Shigetarō CHIBA**. [J. I. E. E. Japan, **458** (1926), 1017-1026, with fig.]—Various problems concerning multi-stage amplifiers are dealt with. The selective characteristics are explained. That the reactance or the transformer amplifiers whose magnetic circuits are closed ones made of iron sheets, have a very good non-selective characteristic is owing to the fact that (a) the iron loss flattens the characteristic curve at resonant-frequency, and (b) for frequencies lower than the resonant-frequency the effective permeability of the core and hence the plate impedance increase to a certain extent.

Expressions of the amplification per stage are given for both selective and non-selective amplifiers. In the selective type multi-stage amplifiers, the amplification per stage should not be too high. Otherwise the amplifier will have the following disadvantages:—(a) It damages the quality of speech or music for the receptions of wireless telephony because of the frequency distortion. (b) It is liable to start the self-oscillation of the system. (c) It is not suitable for the reception of high-speed telegraphs. By narrowing the amplifying band or increasing the selectivity, the time required for the current to be built up is proportionally increased.

Problems on the reaction (regenerative) coupling and the amplitude distortions are dealt with. Devices which automatically prevent such distortions in the amplifier system are explained.

The transient phenomena in the amplifiers when the frequency is not too high, is briefly considered. It is pointed out that for the selective-type amplifiers these problems are very important and must be taken into account in the designing of such amplifiers.

Author.

**44. Disruptive Strength of Transformer-Oil in Strong Magnetic Fields** (Japanese). **Yotsuo TORIYAMA** and **Shōzō YOSHIDA**. [J. I. E. E. Japan,

**458** (1926), 1034-1038, with fig.]—The authors tested the disruptive strength of transformer-oil using sphere and needle-electrodes in a magnetic field of about 6,000 and 11,000 gauss. They found that in the case of sphere-electrodes the disruptive strength increased about 3% in a field strength of 6,000 gauss and 4% in a field strength of 11,000 gauss respectively.

They found, however, in the case of needle-electrodes that the magnetic field has no effects on the disruptive strength of transformer-oil. Authors.

**45. On the Discharge Character of Spark-gaps subjected to Impulsive Over-voltage with Steep Wave Front** (Japanese). **Shigeo MOCHIZUKI**. [J. I. E. E. Japan, **458** (1926), 1039-1048, with fig.]—Utilizing as a Crest-voltmeter Lichtenberg's figure obtained on the rotating film, which was connected in parallel with the gap under test, the writer investigated the discharge character of various gaps subjected to impulsive over-voltages. The value of the impulsive voltage was chosen so high as to afford the discharge in the test gap before its peak value has been reached. The peak value of the impulsive voltage employed was about 13 K.V. and its wave front up to 8 K.V. was estimated to have the steepness corresponding to the wave length of 42 metres.

The results of the experiments show that:—

(1) Under the equal impulsive over-voltage supply, the impulse-ratio referred to the continuously applied a. c. breakdown-voltage becomes the higher, the shorter the gap-length.

(2) When the gap-lengths are adjusted so as to discharge at equal value of continuously applied voltage, the sphere-gap and needle-gap give a nearly equal impulse-ratio for equal impulsive over-voltage. Wide difference in discharge character between F. W. Peek's experiments, which are made at critical voltages, and that of the present author midway in the rise of impulsive over-voltage is noted and deserves further study.

(3) As to the impulse-voltage discharge between the unsymmetrical electrodes, the characteristic curves relating to the breakdown-voltage and the gap-length are similar for both positive and negative discharges, with those obtained under rectified pulsating D. C. voltage. In both cases, the curves cross at about 2.2 mm. gap-length and at shorter distances the spark-over voltage is larger when the point electrode is positive and smaller when it is negative, for longer spacings the reverse being the case. Author.

**46. On the Tests of Cone and Horn-Type Loud-speakers with Special Reference to the Motional Impedance.** **Kanesaburō KUROKAWA** and **Tomoyoshi HIROTA**. [J. I. E. E. Japan, **458** (1926), 1049-1068, with fig.]—The performance characteristics of cone and horn-type loud-speakers by a prominent maker were studied from the point of view of their motional impedance. The results of which practically coincide with the conclusion already attained by a more complicated method.

The absolute values of the motional impedance, which is the measure of the velocity of the actuating element, varied remarkably for different frequencies. If judged according to these impedance vs. frequency curves, the horn-type speaker gives a more uniform response than the cone-type as concluded by Minton from his measurement of sound-pressures.

It is, however, obvious that the total reproductive character cannot be judged from such test results of the speaker alone, for the correlated circuit constants have a great preponderance upon it. Even when concerned with a loud-speaker only, the distortions for their own sake must be investigated from at least two standpoints. One of them is the

ordinary frequency-response characteristics as studied by several experimenters and the other is related rather to its behaviour under quasi-stationary or transient conditions. The actual superiority of the cone-type over the horn speaker must be attributed to the reverberation inside the horn under transient conditions.

The present report is concerned with frequency-response characteristics as studied from the input side in a steady state. The characteristics of vibrators alone were also studied in the same manner. Authors.

**47. A New Form of Frequency Meter** (Japanese). **Shigetarō CHIBA.** [J. I. E. E. Japan, **459** (1926), 1121-1126, with fig.]—The paper describes a new form of frequency meter for the accurate measurement of acoustic frequencies. The connections

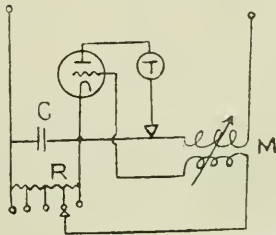


Fig. 1.

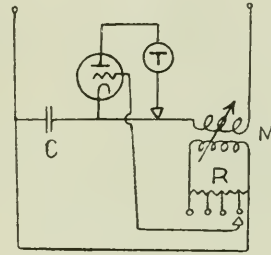


Fig. 2.

used are as shown in Fig. 1 and 2.

The frequencies are given from the approximate formulae

$$f = \frac{2}{2\pi\sqrt{nCM}} \quad \text{and} \quad f = \frac{\sqrt{n}}{2\pi\sqrt{CM}}$$

in these cases. Given the tap position of the high resistance  $R$  in these figures, the constant  $n$  in the above formulae can be changed. The frequency is then found by multiplying the reading of the scale by this factor  $n$ . The variable resistance in the plate-circuit of the triode amplifier is used to compensate the effect of the resistance which shunts the capacity  $C$ . It is explained with numerical examples that, by a suitable choice of the quantities  $C$ ,  $M$ , and  $R$ , the error may be reduced to less than 1% over the entire range of the frequency to be measured. Author.

**48. Some Properties of Mica at High Temperature** (Japanese). **Matsujirō OYAMA.** [J. I. E. E. Japan, **459** (1926), 1127-1136, with fig.]—Some experiments on Indian mica (muscovite) have been carried out at temperatures up to about 800°C.

Electrical conductivity seems to be constant in variable voltages, but varies with temperature as

$$\log I = b - \frac{a}{T}$$

where  $I$ =current,  $T$ =absolute temperature, and  $a$  and  $b$ =constants.

Change of weight is observed during the temperature rise up to about 800°C., and

it is affirmed that water of crystallization is driven off, at temperatures from 100°C. to about 600°C., and water of constitution (about 4.6%, an equal quantity to that calculated from the chemical constitution formula) is also driven off at about 700°C.

When mica thus burns, it becomes opaque and soft, then the property is much depressed both mechanically and electrically.

Optical properties, percussion figure, and X-ray Laue figures are examined in relation both to burned and to normal mica, and some comparisons and discussions are given.

Author.

**49. Improvement of Transmission Characteristics by Synchronous Condensers at a Point Midway in the Long-Transmission Line** (Japanese). **Mitsuru MASHIKO**. [J. I. E. E. Japan, 459 (1926), 1137-1153, with fig.]—By means of synchronous condensers at a point midway in a long-transmission line, the limit of static stability of the system is greatly enlarged.

Moreover, the transmission characteristics are improved so as to reduce the total condenser capacity and efficiently operate generators in the system.

In this paper, the author investigates the relation between the characteristics in the above conditions in detail, and applying this relation, explains that synchronous machines at any station can be utilized for another station in those systems where the machines are inadequate for their own supply.

In the present practice synchronous condensers and their accessories for this purpose must be manufactured so as to withstand the continuous over-voltage of about 10% rise.

Author.

**50. On the Wave Length Variation of a Short Wave Oscillators Coupled with Lecher Wires** (Japanese). **Yasushi WATANABE**. [J. I. E. E. Japan, 459 (1926), 1154-1160, with fig.]—The author considers the jumping phenomena which take place in the variation of wave length of oscillation produced by means of a short wave valve oscillator, when a secondary circuit containing Lecher's parallel wires is coupled magnetically.

As the length of the parallel wires increases, the wave length of oscillation increases gradually beyond the value  $\lambda_1$  of the oscillator itself, but at a certain point  $l_1$ , it decreases suddenly down below  $\lambda_1$ . Continuing to increase the length of wires, the second sudden decrement of the wave length occurs at a point distant from  $l_1$  by a half-wave length  $\lambda_1$ .

Such a phenomenon takes place similarly when the receiving end of the parallel wires is shorted or open only with the difference that the jumping points in these cases differ by a quarter-wave length  $\lambda_1$ .

These jumping phenomena may be explained qualitatively by considering the effective impedance of the parallel wires at the sending terminals, and then by reducing it into a simple coupled circuit containing a valve oscillator, the characteristics of which have been dealt with exhaustively by many investigators.

The wave length is measured, in the author's experiment, by a wave-meter, which is calibrated by the Lecher wire method.

Author.

**51. The Symbolic Form of Lagrange's Equation for a System in Periodic Motion, and the Law of Conservation and Transformation of Vector-Power for a System of Periodic Current Flowing in an Electrical**



**Network** (Japanese). **Heiichi NUKIYAMA**. [J. I. E. E. Japan, **459** (1926), 1161-1190, with fig.]—The expression of complex instantaneous power and complex average power (vector-power) of a periodic current is given. A special character of a homogeneous functions of second degree is explained. This is utilized to deduce the law of conservation and transformation of vector-power in an electrical network from the symbolic form of Lagrange's equation. The formula which shows the law of conservation of vector-power for  $n$ -th harmonic is

$$\sum_{p=1}^k [\dot{V}_{p,n} \dot{I}_{p,n}]_p + \sum_{(pq)=1}^l [\dot{E}_{pq,n} \dot{I}_{pq,n}]_p = \dot{J}_{2,n} + j 2 n \omega \{ \dot{T}_{2,n} - \dot{U}_{2,n} \},$$

and the formula which may be made the basis for treating the frequency transformation by complex circuit constant is

$$\sum_p [\dot{V}_{p,n} \dot{I}_{p,n}]_p + \sum_{(pq)} [\dot{E}_{pq,n} \dot{I}_{pq,n}]_p = \dot{J}_n + j 2 n \omega \{ \dot{T}_n - \dot{U}_n \}.$$

This formula is utilized in dealing with the problem of resistive, inductive and condensive frequency-transformations.

Author.

**52. A Method of Mapping Equipotentials and Lines of Force, and Calculation of Capacities between Parallel Conductors by Successive Application of Simple Conformal Transformations.** **Kanesaburō KUROKAWA**.

[J. I. E. E. Japan, **459** (1926), 1191-1212, with fig.]—By taking the  $n$ -th root or vector inverse figure of concentric circles and radial lines, namely equipotentials and lines of force for a single line charge of infinite length and by applying the same process successively one after another, a number of graphs of equipotentials and lines of force have been mapped out for two or more line-charges, equal or unequal, of the same or opposite signs.

Such orthogonal systems of curves, although the solvable cases are restricted, can far more easily be traced by the present method than by plotting the curves from their equations. More than one hundred simple cases obtainable by this method are tabulated, some being actually worked out.

Capacities between cylindrical conductors of some complex sectional forms which are obtained by the above method as equipotentials, if the capacity of their mother-conductors are known, may easily be calculated by simply replacing the old dimensions of the capacity of mother-conductors by the new ones and multiplying them by  $n$  when the transformation process is the  $n$ -th rooting and by unity when inversion. Several important cases are worked out, some of them being checked by known values.

Author.

**53. Communication-Test of Short Waves across the Pacific** (Japanese).

**Toyokichi NAKAGAMI** and **Takeo KAWAHARA**. [J. I. E. E. Japan, **460** (1926), 1251-1264, with fig.]—A communication-test on short waves across the Pacific was carried out in order to see what wave length should be used for trans-Pacific communication and to find the wave length which gives the signal strength at a certain distance both at night and in the daytime.

The 500-watt short-wave transmitter was installed on board S. S. "Shunyo Maru" for that purpose, while the short-wave transmitters of the Training School of the Department of Communications, Shiba, Tokyo, of Iwatsuki Radio Station near Omiya and of Ottishi Radio Station near Nemuro were utilized for the transmission to S. S. "Shunyo Maru."

The wave lengths of these stations were as follows:—

Name of Station.	Training School.	S. S. "Shunyo Maru."	Iwatsuki.	Ottishi.
Wave length.	21.5 m.	30 m.	40.5 m.	43 m. 115 m.

Transmission was done two or three times a day by each station, so as to be able to compare daytime and night transmissions. The S. S. "Shunyo Maru" left Yokohama on Feb. 21st and arrived at San Francisco via Honolulu on March 8th this year. During her voyage the stations concerned sent test signals as scheduled which were received by others every day. During her homeward voyage from the departure from San Francisco on March 17th to the arrival at Yokohama on April 2nd, the same test was made.

The signal strength measured every day was plotted against distances, from which we find the following facts:—

(1) 40.5 metre wave may be used with fairly good results for the whole range up to 8,400 kilometres at night.

(2) 21.5 metre wave is far better than 40.5 metre wave for daytime transmission.

(3) Skip-distance phenomena is remarkably shown by the audibility curves, and

(i) The shorter the wave the greater the skip distance we have.

(ii) The shorter wave skips more at night than in the daytime.

(4) For a certain distance there is one wave which gives the same signal strength both at night and in the daytime. From the curves we got 21.5 metre for 3,100 km., 30 metre for 1,500 km. and 40.5 metre for 520 km. A curve is drawn from these data showing a relation between the distance and the wave length, which is very valuable for choosing the wave length to be used for a certain distance. It must be noted that this curve is good only in this season (February 20 to April 2) of the year. Probably the curve will be lowered in summer and raised in winter, because the shorter wave is suitable in summer and the longer wave in winter, which was evidenced by our short-wave test of more than one year.

Authors.

**54. Practical Photometry with a Photo-electric Cell** (Japanese). **Shige-hiro SEKI**. [J. I. E. E. Japan, **460** (1926), 1265-1272, with fig.]—The author succeeded in applying photo-electric cell for practical photometry. A good screen was made by potassium bichromate, avoiding an error caused by colour selectivity. Illumination measurement seems hopeless, because it is very hard to get a component in any direction, for example, horizontal illumination.

Author.

**55. Moll's Thermopile of Radiometric Use** (Japanese). **Matsujirō ŌYAMA**. [J. I. E. E. Japan, **460** (1926), 1273-1283, with fig.]—Moll's thermopile of "small surface pattern" made by the Cambridge Sci. Instr. Co. was tested in the author's laboratory. Its direction characteristics peculiarly deviate from the cosine law, for active elements are arranged in a straight line, not having point-symmetry against its window, and moreover a conical reflector makes the sensibility more directive.

Several test results obtained with the reflector are also described.

Author.

**56. A Thermionic Theory of Electrical Conductivity of Dielectrics** (Japanese). **Hikoo SAEGUSA**. [J. I. E. E. Japan, **460** (1926), 1284-1291, with fig.]—

Assuming that the electrons by which electrical conduction in dielectrics is carried out, are of thermionic origin, the number of these electrons in unit volume is given by Richardson's formula in the case of thermionic emission. Considering the re-combination of electrons with the parent ionized atoms, the author deduced the number of electrons which actually convey the electronic conduction, and thus obtained the expression for the electrical conductivity as a function of temperature and of material constants.

Comparing the expression with the author's experimental results for quartz, a good coincidence between the theory and the experiment were obtained, and thus the theoretical curves expressing the variation of the electrical conductivity of quartz due to temperature agrees satisfactorily with the experimental curves, up to a certain high temperature; and also reasonable values for the acting radius of the atoms in quartz and for the equivalent potentials for the emission of an electron from the atom in quartz were deduced. Putting  $\phi = h\nu$ , the author deduced the natural frequencies and its wave lengths for quartz plates, one cut parallel and the other perpendicular to the optical axis; these values fall also within the range of values actually observed by Listing and by H. Rubens and Nichols.

Author.

**57. Equivalent Networks and Current Loci of Unbalanced Induction Motors** (Japanese). **Yukito TAKAHASHI**. [J. I. E. E. Japan, **460** (1926), 1292-1320, with fig.]—The author reduces the equivalent networks of the unbalanced induction motors to the following four cases:—

(1) Case of the unbalanced voltages impressed upon terminals of the polyphase induction motor.

In this case the primary current is the resultant of two current vectors, which can be obtained by the equivalent circuits of two balanced induction motors respectively. The current locus of the primary current is not a circle, but becomes a higher algebraic curve called "Bicircular quartics."

(2) Single phase induction motor.

A single phase induction motor is a special case of (1), but the author has treated it separately and reduces the equivalent network. The current locus becomes also a curve of "Bicircular quartics," which in this case approximately becomes a circle.

(3) Case of the unbalanced external resistances added to the secondary phase windings.

The author reduces the equivalent network and the current locus of the primary current by solving differential equations in this case.

The primary currents divided in two symmetrical components, both describe higher algebraic curves, the one has the same frequency as that of the supply voltage, and the other has a frequency of  $(2s-1)$  times the frequency of the supply voltage, where  $s$  is a slip.

(4) Case of the polyphase induction motor with single phase secondary winding.

This is a special case of (3), and this is known as Görges' phenomena.

The author reduces also the equivalent network and the current locus. Author.

**58. A Simple Portable Testing Set of Arresters for Weak-Current Communication Networks** (Japanese). **Takeshi NISHI** and **Masaharu HOSHIAI**. [J. I. E. E. Japan, **461** (1926), 1404-1422, with fig.]—This is a report on a simple portable testing set, devised by the authors, for vacuum discharge-type arresters, used in weak-current communication networks. This testing set consists mainly of a small variable transformer, a condenser and high resistances and is provided with a "glimm" lamp as a detector. The test current is taken from an ordinary lighting circuit and with simple

manipulation it is able to test the insulation and discharge characteristics of the arrester.

The set may also be applied to test an ordinary carbon-gap arrester, though designed for the vacuum discharge-type ones. In the appendix, the authors treat of the discontinuous discharge phenomena of a "glimm" lamp with D. C. and A. C. supply. Authors.

**59. *Observations on Atmospheric Disturbances*** (Japanese). **Toyokichi NAKAGAMI** and **Kinzō KANEKO**. [J. I. E. E. Japan, **461** (1926), 1423-1436, with fig.]—Observations on atmospheric disturbances were made at the Osaka Station, Osaka, Japan by the personnel of the Station.

The report contains the general idea of atmospherics, the method and apparatus of measuring them, and the result of the observations.

The conclusions arrived at from the observations are as follows :—

(1) Atmospheric disturbances increase at sunset at the receiving station, the high values prevailing at night, and after sunrise they decrease rather rapidly.

(2) The atmospheric disturbances at Osaka come almost entirely from the direction of the northeast to the southwest. This seems to warrant the assumption that atmospherics in general originate over the land rather than over the ocean.

(3) During the summer, they come from a northeasterly direction and during the winter from a southwesterly direction. This also warrants the assumption that the sun has an important bearing upon the sources of atmospherics. It seems that the sources of atmospherics follow the sun in its changing path between the northern and southern hemispheres. Apart from the local atmospheric disturbances of the mountain range of Japan called "Japan Alps" those of distant atmospherics predominate. This fact is endorsed by the directional observation at Iwatuki near Tokyo, where the atmospherics came from the northerly to northwesterly direction.

(4) The measurement at Peking during October and November combined with the data obtained at Osaka indicates that the origin of atmospherics of this season is the tropical district of the Dutch Indies. Authors.

**60. *The Performance and Design of the Sound Radiator consisting of the Acoustic Transformer and the Horn*** (Japanese). **Katsuichirō KOBAYASHI**. [J. I. E. E. Japan, **461** (1926), 1437-1444, with fig.]—In most cases, the horn is used in connection with the acoustic transformer. It is pointed out in this paper that the frequency characteristic of the acoustic impedance at the sending side of such a combined system is simple in nature, and design procedure becomes much simpler by considering such an impedance. The criterion and design procedure of such a combined system are given, together with a chart which enables us to determine, under a certain criterion, the dimensions of an exponential horn of finite length. Author.

**61. *Uses of the Transformer in removing Pulsations in D. C. Voltage*** (Japanese). **Minoru TAKATA** and **Seitoku HAMADA**. [J. I. E. E. Japan, **461** (1926), 1445-1453, with fig.]—Pulsation in d. c. voltage is removed by using the transformer and battery. The method has some advantages in that: (1) it is independent of forms and frequencies of pulsating waves; (2) it is simple; (3) pulsations at no load are markedly depressed.

The authors show these experimentally.

Authors.



**62. Selective Cut-Out of Parallel Feeders in Transmission Lines** (Japanese). **Hisanao HIROYAMA**. [J. I. E. E. Japan, **46** (1926), 1454-1469, with fig.]—In a system in which the neutral is connected with the ground through a high resistance, fault-current in case of a one-line ground is generally smaller than normal full-load current, but symmetrical three-phase short-circuit current and line-to-line short-circuit current are always greater than full-load currents. The ordinary relay systems which are used nowadays, i.e. current balance relay, over current relay, etc. give, practically, satisfactory protection for short circuits. But the author has shown that for one-line ground, no relay system used nowadays gives any satisfactory protection. A relay which has potential and current coils solves this problem. But potential transformer of such a high tension as 110,000, 154,000, 220,000 volts is practically impossible to use. Author.

**63. A Type of Isocandles** (Japanese). **Zirō YAMAUTI**. [J. Ill. Eng. Soc. Japan, X., **2** (1926), 69-73, with fig.]—The choice of a certain horizontal angle on "Isocandles" as proposed by Benford, cannot be got directly. In this paper, another type of isocandles is proposed. The web consists of concentric circles and radial lines. The former represent the vertical angles  $\theta$  and the latter the horizontal ones  $\phi$ . The radius of the circle has the length of  $\sqrt{2} R \sin \frac{\theta}{2}$ ,  $R$  being the largest radius, and the scale of  $\theta$  is practically uniform. This type of isocandles has the following advantages: (1) it represents the actual horizontal angles, and (2) it enables us to get the total hemispherical lumens, though it is inferior to that of Benford to see the features in both hemispheres at one time. The loci of the great circles are also shown. The tables given by Benford can be used effectively. Author.

**64. Analytical Calculation of Interior Illumination, I** (Japanese). **Zirō YAMAUTI**. [J. Ill. Eng. Soc. Japan, X., **5** (1926), 213-216, with fig.]—The author proposes a method to calculate the interior illumination analytically in order to predict the illumination in "situ."

The flux-of-light method gives only the mean illumination which is the value when no one is in the room, and may be said to be a statical method. The new method gives the approximate values by which we can foresee the illumination taking the shadow effect into account.

Interior illumination is composed of direct and diffused illumination. Direct illumination can be obtained by a point-to-point method, which can be considered to be a vector; diffused illumination can be obtained by making use of the mean diffused reflection factor  $\rho$ , mean absorption factor  $\alpha$ , total area  $S_o$  and total flux  $F$  by the formula

$$\frac{\rho}{\alpha} \cdot \frac{F}{S_o},$$

which is nothing but the "Mittlere diffuse Raumbeleuchtungsstärke" proposed by Ondracek.

To check the method, the author calculated the coefficient of utilization by this method which gives the formula

$$\eta = \left[ \frac{F_s}{F} + \frac{\rho}{1-\rho} \cdot \frac{S}{S_o} \right] \epsilon$$

where,  $F_s$ =the flux which reaches the working plane directly from the source,  $S$ =the

area of the working plane,  $\varepsilon$  = the efficiency of the fixture used. The results fairly well agreed with those shown in the text books using room index.

By this method we can get the variation-ratio, variation range, daylight factor, and sill-ratio as well. Author.

**65. *The Relation between the Efficiency and Life of Tungsten Lamps.***

**Mituyosi IGARI.** [J. Ill. Eng. Soc. Japan, X., 5 (1926), 217-224, with pl.]—The life of tungsten lamps is generally determined by the rate of vaporization of tungsten and may be calculated if the necessary conditions are given. The author has calculated the life of the lamps having various efficiencies under the assumption that any filament is considered to have burnt out when the current through it decreases to within a certain definite ratio of the initial value. The relation obtained may be expressed by an exponential formula, the exponent being 7.5. The exponent of actual lamps ranges from 6.6 for smaller filament lamps to 7.4 for larger filament ones. The discrepancy between the calculated and actual values of the exponent may be explained by the fact that the mechanical cause of breakage of the filament is more probable when lit at lower efficiencies than otherwise. This may also explain the fact that the exponent of smaller filament lamps is smaller than that of larger filament ones. Author.

**66. *On the Spherical Reduction Factor of Incandescent Tungsten Lamps.*** **Iwao HONJOH.** [J. Ill. Eng. Soc. Japan, X., 6 (1926), 239-258, with fig.]—

The author describes the results of tests to obtain the spherical reduction factors of incandescent tungsten lamps of various types.

In the first place he considers the effects of bulb sizes and then the frosting of bulbs upon the values of the spherical reduction factors. Then he deals with the actual data on the lamps of the present manufacture not only for the 100-volt type but also for 200-volt and 50-volt types. Author.

**67. *Analytical Calculation of Interior Illumination, II*** (Japanese). **Zirō**

**YAMAUTI.** [J. Ill. Eng. Soc. Japan, X., 6 (1926), 266-270, with fig.]—As an extension of the previous method, the author proposed a diagram of "solid angle projected." The radius vector of the diagram is  $R \sin \theta$  and the polar angle is the horizontal angle, where  $R$  is the radius of the diagram and  $\theta$  is the incident angle. Then if we plot the contour of the light source on the diagram, the area of the diagram gives the illumination at that point.

Using the projected-angle diagram with meridians which represent the time of the day, we can solve the various problems of the orientation of the window. Author.

**68. *Damping-Constant Measuring Instrument*** (Japanese). **Shun-ichi**

**FUKUDA.** [Researches, Electrot. Lab. Japan, 163 (1926), 1-28, with fig.]—The author deals with a new A. C. measuring set by means of which the working capacity and the conductance between any two wires of telephone cables can be determined at the same time with a great accuracy and simplicity.

The construction of the set designed by the author is explained in detail and the actual performance is described.

From these results, it is confirmed that the author's set, when it is properly adjusted, is accurate enough for the measurement of the working admittance between two wires of

a telephone cable even when the deviation of the admittances between two wires and the earth amounts to about 20%.  
 Author.

**69. *Voice-Frequency Telegraph System*** (Japanese). **Teijirō HORIE** and **Hirotoishi SUGIURA**. [Researches, Electrot. Lab. Japan, **164** (1926), 1-29, with fig.]—The paper describes a voice-frequency telegraph set designed and constructed by the writers. It consists of four channels: 500, 700, 900 and 1,100 cycles respectively, and its principal equipment is as follows:—

Transmitting equipment: Vacuum-tubes are used as generators of a. c. source and a key or automatic transmitter is connected to the output coil of the oscillator and closed by a resonance circuit associated to each channel. The reason for using a resonance circuit is to reduce the losses caused by connecting up each channel in series to a line transformer; also its use has another advantage as it works as a harmonic absorber.

Filters: Receiving filters are designed to transmit a frequency band of 200 cycles for each channel, and besides them three kinds of filters with a frequency range of 50, 75 and 100 cycles are provided to study transient phenomena.

Receiving equipment: Vacuum-tubes are used to rectify arriving currents and the P. O. type relay or the Wheatstone automatic receiver was inserted in the plate circuit.

The experiments carried on an artificial line (Artificial standard cable of 51-B artificial line) proved to be satisfactory. It transmitted over 25 miles S. M. with Wheatstone speed of 300 letters per minute (corresponding to 110 words in English) without using any amplifier.  
 Authors.

**70. *Surface of Metal and Semi-Conductors*** (Japanese). **Genki SADA-KIYO**. [Researches, Electrot. Lab. Japan, **166** (1926), 1-31, with fig.]—If any metal is used at both electrodes to impress a direct potential difference upon the semi-conductor, the current, in general, decreases at first, but about half a minute later it begins to increase. After some time, from several minutes to hours depending on circumstances, it becomes smaller and smaller, continuing for hours. This phenomenon is exceedingly remarkable in the case of tin-foil electrodes. The author proposes the following explanation for the cause of the current-changing: The first decreasing of the current is due to the dielectric absorption-current through the initial contact. The next increasing of the current is mainly due to the increase of the conduction-current and also the dielectric absorption-current, resulting from the development of the contact, chiefly the broadening of the contact area, on account of the electrostatic attraction. The second decreasing of the current is due to the vanishing of the dielectric absorption-current and to the increase of the effective resistance at the contact on account of the electrochemical product, the electrochemical polarization, and the back electromotive force of accumulated ions.  
 Author.

**71. *Vibrating Rectifiers*** (Japanese). **Tsunehachi AIZAWA**. [Researches, Electrot. Lab. Japan, **167** (1926), 1-54, with fig.]—The author deals with vibrating rectifiers covering both the theoretical and practical sides of the subject.

As to the theory, he describes the relation between the vibromotive force and the displacement of the vibrator, the effects of the frequency as well as voltage of the source on the rectification, the efficiency of the rectifier and so forth, while as to the practical side, he describes the construction and performance of various kinds of rectifiers made in Japan and America, giving experimental data.  
 Author.

**72. On the Method of Measurement of Zero and Negative Phase Sequence-Impedance of the Three-Phase Alternator.** Sadatoshi BEKKU, Mokuji DOTE and Matsujirō URUSHIBATA. [Researches, Electrot. Lab. Japan, 170 (1926), 1-20, with fig. and pl.]—To know the behavior of the three-phase alternator with unbalanced load, three characteristic impedances of the machine viz., zero, positive and negative phase sequence-impedances, are required. In this paper various methods of measuring these impedances are shown and the results of test performed on several machines are compared. The most convenient practical method of measuring the negative phase sequence-impedance is to short-circuit two terminals *b* and *c* directly and connect the remaining terminal *a* to the short-circuited terminals through any convenient resistance or impedance *Z*. Measuring the current in each line, the negative phase sequence-current  $I_{a2}$  referred to  $I_a$  is easily obtained graphically. If the negative phase sequence-impedance of the alternator under test be  $Z_2$ , then it is shown in the text

$$\frac{I_a}{I_{a2}} = -\frac{3Z_2}{Z}.$$

Since *Z* is known,  $Z_2$  can be obtained in magnitude as well as in phase angle. The values of  $Z_2$  measured with various different methods agree very well. This fact shows that the method of symmetrical co-ordinates, which is rigorously correct for the ideal alternator, is also applicable with engineering accuracy to the commercial alternator. Authors.

**73. Electrical Properties of Copper-Nickel Resistance Alloys.** Skezug KIMURA and Zunehachi ISAWA. [Researches, Electrot. Lab. Japan, 171 (1926), 1-10, with fig.]—The authors determine the relation between the electrical resistance as well as its variation with temperature and the chemical composition of copper-nickel alloys so as to enable us to manufacture the alloys of any desired specific resistance and having any desired form of resistance-temperature curve. The resistance change with temperatures is measured from 200° to 800°C. for the alloys of various nickel contents, and it is found that the resistivity-temperature curve of the alloys in certain range of nickel content has one maximum and one minimum. This mode of resistance-change is somewhat similar to that with nickel-chromium alloys and copper-manganese alloys in certain range of composition, and it seems to be a general property of solid solutions of some compositions. But according to the authors' opinion the experimental results are yet insufficient to proclaim this generality and to propose a theory about this phenomenon.

It is an unsolved question whether copper-nickel alloys make a series of continuous solid solutions or not. The authors discuss the problem in detail and suggest that to solve this question attention must be paid to the following points: (1) the samples must be pure in the highest degree, (2) it should reasonably be decided under what convention Curie-points are to be determined from susceptibility-temperature curves. Authors.

**74. On the Synthesis of Galena Crystal** (Japanese). Wakasaburō OGAWA, Chūjirō NEMOTO and Seiji KANEKO. [Researches, Electrot. Lab. Japan, 173 (1926), 1-59, with fig.]—Lead sulphide prepared by precipitation was fused with many other metallic sulphides and the products were tested for sensitivity as radio detectors. Silver sulphide and thallium sulphide were proved to be most beneficial. The authors recommend the following receipts:—

- (1) PbS 92.5 parts, Ag<sub>2</sub>S 7.5 parts, and S 1.5 parts.
- (2) PbS 99.5 parts, Tl<sub>2</sub>S 0.5 parts, and S 1.5 parts.



Characteristic curves and a table of sensitivity of synthesized crystals in comparison with the best crystals now in the Japanese market are given. The effects of cooling speed and annealing are also discussed. Authors.

**75. Measurement of  $dE/dT$  in Mercurous Sulphate Electrodes, and the Application of the Mercurous Sulphate Electrode to Secondary Battery Testing** (Japanese). **Sakae MAKIO**. [Researches, Electrot. Lab. Japan, 174 (1926), 1-20, with fig. and pl.]—The author prepared the mercurous sulphate electrode as the standard for secondary battery testing. The test results of this normal electrode show that: (1) single potential difference of the normal electrode at 18°C. is 0.6758 volt on a hydrogen scale; (2) the change of E. M. F. of the electrode with temperature is 0.00026 volt per degree and has a negative sign; (3) E. M. F. of the electrode at  $t^\circ\text{C}$ . is represented by the equation,

$$E_{\text{Hg}}(t) = 0.6758 - 0.00026(t^\circ - 18^\circ).$$

M. H.

**76. On the Current Carrying Capacity of Rubber Insulated Wires in Iron Conduit Pipes** (Japanese). **Masaie HORIOKA and Ushiya TAKABAYASHI**. [Researches, Electrot. Lab. Japan, 176 (1926), 1-18, with pl.]—The authors give the current carrying capacity of rubber insulated wire embedded in an iron conduit pipe for the case of one, two (for single-phase circuit) and three (for balanced three-phase circuit) wires contained in one pipe, under the assumption that the maximum allowable temperature of rubber or conductor surface be 55°C., or the allowable temperature rise is 15°C. When only one wire is contained which is analogous with the case of unbalanced three-phase circuit drawn in one pipe or with the single conductor armoured cable, the eddy-current loss in the pipe, effects the temperature rise of the conductor, especially when the conductor-current or the ohmic loss is relatively small.

It is concluded for the rubber insulated wires of the sectional area of less than 50 mm.<sup>2</sup> (B. S. No. 0) that:

(1) The effect of eddy-current loss in steel pipe decreases with the increase of the conductor-current and the percentage of the current carrying capacity of wires in iron pipe to be decreased is in the order,

- 1, 3 and 2 wires in one pipe for smaller current,
- 3, 1 and 2 wires in one pipe for medium current,
- 3, 2 and 1 wires in one pipe for larger current,

i. e., for larger current, the ohmic loss mainly determines the current carrying capacity.

(2) The conductor-current in an iron pipe which gives the same temperature rise (15°C.) in the conductor as that in air must decrease in the order,

- 2, 3 and 1 wires in one pipe for a sectional area larger than 14 mm.<sup>2</sup> (B. S. No. 6).
- 1, 2 and 3 wires in one pipe for a sectional area smaller than 5.3 mm.<sup>2</sup> (B. S. No. 10).

(3) We may take the current carrying capacity in an iron pipe to be about 65% for three-phase circuit drawn in one pipe, 70% for two lines of single phase drawn in one pipe and 61 to 75% for only one A. C. line in a pipe, the smaller value being applied to the wires of larger cross section.

(4) When the pipe is totally enclosed as in a wooden duct, the current carrying capacity must be taken about 93% of the value above described.

(5) Short-circuiting the ends of an iron pipe of less than three metres containing an A. C. flowing conductor gives no appreciable temperature rise of the pipe.

(6) When the pipe is supported in a vertical position, the current carrying capacity of wire should be taken somewhat smaller, say from 90 to 95 per cent. of the current for a horizontal position, probably because hot air accumulates somewhere near the middle point of the pipe.

Authors.

**77. *A Simplified Method of Calibration of a Wavemeter by Standing Waves on Parallel Wires.*** Eijirō TAKAGISHI, Kokichi HATAKEYAMA and Shigeyoshi KAWAZOE. [Researches, Electrot. Lab. Japan, 177 (1926), 1-19, with pl.]—A simplified method of calibration of a wavemeter for use in radio developed by the writers is described in detail. The method utilizes standing waves on parallel wires as originally worked out by F. W. Dunmore and F. H. Engel, but it is considered that the present method is superior in that it requires no other apparatuses than a petty portable oscillator set fitted with a small tube such as Radiotron UV-199 instead of having to instal a powerful oscillator set to enable one to read standing wave current by a hot wire ammeter bridged across parallel wires.

The portable oscillator set contains in its anode circuit a d. c. milli-ammeter which serves to indicate resonance point very easily and accurately. Thus the portable oscillator set serves not only as a power source of oscillations to cause standing waves on parallel wires but also at the same time as a sensitive resonance indicator.

That an observer at the oscillator can do all the necessary things without any assistant, will be also advantageous from a practical point of view.

An experimental result is added for the case where parallel wires are opened at one end, no bridging strip being attached.

Authors.

**78. *Furfural Resins as Electrical Insulating Material*** (Japanese). Wakasaburō OGAWA, Tatsurō HANYU and Torao YANAGIHASHI. [Researches, Electrot. Lab. Japan, 178 (1926), 1-78, with fig.]—The effects of many condensing agents in the formation of furfural resins were investigated and the resins obtained were examined for their properties necessary as electrical insulating material.

It is concluded that most of the furfural resins were found not to be excellent insulating materials as the formaldehyde resins of bakelite type, and can not be recommended to be used alone in the form of spirit varnish or molded insulation. But as the resins have a charming black colour and absorb completely ultra-violet rays, by adding a suitable amount of bakelite resin, they can supply a very fine ebonite-like insulating material or effective coating varnish protecting ebonite from ultra-violet rays.

Authors.

**79. *On the Voltage Wave-Form of Direct Current Machines*** (Japanese). Masakazu TAKAHASHI and Shintarō TOH. [Researches, Electrot. Lab. Japan, 180 (1926), 1-52, with pl.]—The authors treat of the general wave-form of direct current machines and analyse these voltage ripples. They show the origins or sources of these ripples, their natures, frequencies and effects. The research was accomplished chiefly by the aid of oscillograms obtained from the miscellaneous kinds of direct-current machines. The ordinary methods and devices for the suppression of these ripples are compared and discussed. The prevention of ripples can be accomplished by the improvement of the machine itself or by the employment of a wave filtering apparatus. Some oscillographic studies for wave filters are illustrated. As regard to the wave filtering apparatus the authors are of the opinion that though the ordinary resonance-type filters, both shunt and

series types, composed of combinations of inductance and capacity, are recommended for the suppression of rather higher harmonics, the employment of an induction-regulator adjusted to reduce the E. M. F. zero and batteries of low internal resistance or capacity connected in series to the primary of regulator, is also recommendable for the suppression of the mediate and lower harmonics or for some large equipments. Authors.

**80. Calculation of Ground Current Caused by One-Line-Ground in the Three-Phase Transmission Network.** Sadatoshi BEKKU and Koichirō MAYEKAWA. [Researches, Electrot. Lab. Japan, 181 (1926), 1-114, with fig.]—The current distribution caused by a one-line-ground in the widely spread three-phase network is solved mathematically in a simple manner by the use of the method of symmetrical co-ordinates.

The estimation of the ground-current in the case of a one-line-ground is necessary in connection with the inductive interference on the telephone line and with the operation of the selective ground relay.

The computation, though very simple when expressed in the form of a theorem, is actually pretty complicated and especially tangled when several (usually two) circuits are in close proximity as in the usual practice.

The method of symmetrical co-ordinates for the two-phase system is applied to such problem, and the general formulae are deduced. To make use of the general formulae more legible, the computation is carried out in detail for the 154-kv line of the Tokyo Electric Light Co. Authors.

**81. On the Study of the Polarized Iron Core Reactor** (Japanese). Jōji SUGIURA. [Researches, Electrot. Lab. Japan, 185 (1926), 1-35, with pl.]—The general characteristics of the polarized iron core reactor and its behavior as chiefly used current-limiting reactor, both in steady and transient conditions, are studied. At first, the physical meanings of its characteristics are clearly explained, and next, experiments made with two kinds of samples are described in detail.

It is ascertained that in the transient period at a short-circuit condition, the transient reactance of the polarized reactor is not so great as ordinarily supposed from characteristics of the steady-state condition, as a consequence of which the utility of this kind of reactor is diminishing.

Under short-circuit conditions, the suddenly increased A. C. flux due to main increased A. C. makes the mean flux density interlinking the D. C. winding decrease, and consequently the transient increase of D. C. occurs in the D. C. winding to keep this flux density constant. The transient increase of D. C. in the D. C. winding strengthens the polarization and the transient reactance of the reactor gives less value than that which might be expected from the characteristics of steady state polarization. Author.

**82. Insulating Properties of Various Woods at High Voltage** (Japanese). Osamu NARASAKI and Takao AIKAWA. [Researches, Electrot. Lab. Japan, 186 (1926), 1-16, with pl.]—The writers studied the electric insulation of ordinary woods in dry natural state and after impregnation.

At first they observed the surface discharge in dry and wet conditions, and then examined it by means of the Schering bridge.

From the result of the bridge method, it is known that there are two kinds of influ-

ences of impregnation upon the relation between the effective resistance and the applied voltage. Namely the one has a higher effective resistance than the other and its values decrease with the rise of voltage, while the other class is very low from the first and nearly constant.

Among test samples, Cherry-tree, and Hōnoki, Japanese pine-tree, and Katsura (Japonicum) belong to the former class, and Oak, Zelkova-tree, Shoji, Japanese Cedar and Japanese Cypress belong to the latter. Furthermore, the former samples were good in the flash-over test, and generally the latter samples were bad except for Japanese Cypress.

Authors.

**83. Experiments on Electromagnetic Shielding for Long Electric Waves** (Japanese). **Tomozō NAKAI**. [Researches, Electrot. Lab. Japan, 187 (1926), 1-36, with pl.]—The theory of electromagnetic shielding has already been published by J. H. Morecroft and R. H. Barfield, but the writer states the theory more easily and comprehensively, preferring a different form of explanation. He discusses from the well-known skin effect formula, how to select the proper thickness of a metal sheet, according to the kinds of metal and wave lengths used.

Then he gives a series of curves showing the relation for copper and iron sheets, and points out the importance of the careful selection of its thickness in case of copper shielding for such long waves as are used in transoceanic traffic.

Descriptions are made of the experiments for shielding which were executed for the purpose of building up an apparatus for the measurement of field intensity of long electric waves, and the following results have been obtained:—

- (1) The clearance along the edges of the lid of a shielding box should be as small as possible.
- (2) The edges of the lid of a shielding box should overlap with that of the box in the depth of more than 10 cm.
- (3) A small number of small holes on the box give little effect, but a long and slender opening remarkably reduces the shielding effect.
- (4) In case of copper shielding for waves of several thousand metres, attention should be paid to the selection of the thickness of the sheet.
- (5) Any piece of conductor peeping out of the box through a hole or a clearance on it, has marked effect towards the reduction of shielding.
- (6) The distance between the walls of the box and the containing radio-frequency affects the circuit resistance greatly but the wave length slightly.

Author.

**84. Light Distribution of Luminous Sources of a Simple Form** (Japanese). **Zirō YAMAUTI**. [Bull. First Section Electrot. Lab. Japan, I, 1 (1926), 26-32, with fig.]—The light distribution of some luminous sources of simple forms, which are of uniform brightness and to which Lambert's cosine law of radiation applies, are obtained in concrete forms.

The forms considered are (1) helix (one turn), (2) segment of spheroid, the plane of section of which is perpendicular to the axis of rotation and (3) right circular cone whose outsides is luminous. The following can be obtained as the special cases of the above sources: (helix) straight line, and circular ring; (segment of spheroid) sphere, hemisphere, spherical cap, circular disc, and straight line; (right cone) circular cylinder, circular disc, and straight line.



The light distribution of the straight lines of equal length mounted symmetrically with respect to an axis are the same as that of the helix with equal inclination. Author.

**85. The Effect of Atmospheric Humidity on Dielectric Losses and Power Factors in Fibrous Insulating Materials.** Shōji SETOH and Yotsuo TORIYAMA. [Sci. Papers Inst. Phys. and Chem. Research, Tōkyō, III., 45 (1925), 283–323, with fig.]—Dielectric losses and power factors of fibrous insulating materials, such as paper, silk and calico, is treated as well as untreated states, under power frequencies, and the fixed temperature of 30° C. are measured for various humidity conditions. A quadrant electrometer of Dolezalek type was used to measure losses and currents. The care to be taken in applying the electrometer as an electrostatic wattmeter is described in some detail together with the method for calibration. The losses can be expressed by an empirical formula of the form:

$$\log_{10} P = a - nx + mx^2$$

where  $P$  = the losses in  $10^{-6}$  watt per cub. cm.,  $x = \log_{10}(100 - h)$ ,  $h$  = relative humidity,  $a$ ,  $n$  and  $m$ , being constants.

The dielectric losses thus increase enormously with increasing humidity. The power factor increases also in the same manner reaching the limiting value unity at 60–80% humidity, the only exception being well impregnated samples, for which P. F. remains low even at 85% humidity. The dependence of P. F. on frequency (25–75 cycles per sec.) is also described and an equivalent circuit consisting of a high resistance  $r_1$  connected across a capacity  $C$  and a resistance  $r_2$  in series is shown to represent, with a fair degree of accuracy, the actual relation between power factor, and losses with varying frequency.

$$P = E^2 [1/r_1 + r_2/(r_2^2 + 1/\omega^2 C^2)]$$

and

$$\cos \phi = 1/\sqrt{1 + \omega^2 C^2 r_1^2/[1 + \omega^2 C^2 r_2(r_1 + r_2)]^2}$$

are the formulae for losses and P. F., where  $E$  = effective voltage,  $\omega = 2\pi \times$  frequency. In general, P. F. under high humidity decreases with increasing frequency, while that under low humidity remains sensibly constant. These tendencies can be represented by the above formulae very closely given a proper choice of  $r_1$ ,  $r_2$  and  $C$ . Authors.

**86. Some Experiments on a High-Resistance Measuring Instrument "Megger"** (Japanese). Takeshi NISHI and Tomoyuki SŌMIYA. [Bull. Inst. Phys. and Chem. Research, Tōkyō, V., 5 (1926), 407–422, with fig.]—When "meggering" a condensive high-resistance circuit such as a transmission line, a difficulty in reading the indication is often met due to the fluctuation of the megger-needle. The authors investigate the cause of this phenomenon, together with the property of the movable part itself of the megger.

In the first place the authors took the oscillograms of the currents in the current coil of the megger and confirmed that the fluctuation of the needle was caused by the charging current in the condensive circuit due to the irregularity in hand driving of the megger.

In the second they investigated the natural frequency of vibration of the movable part and proposed an empirical formula of the form:

$$f = \frac{K}{2\pi} e^{\frac{1}{2}(a\theta + b)}$$

where  $\theta$  is an angle of deflection of the movable part, and  $K$ ,  $a$  and  $b$  are all constants.

In the sample used in the test (Evershed megger, 500 V, 100 Meg.),  $1/f$  is from 0.2 to 1.3 sec., and therefore the period of rotation in hand operation (0.6 sec.) lies in the range of the resonant period of it.

In practice, the harmonic-mean of the amplitude of fluctuation coincides fairly well with the actual value of the megohm resistance. M. H.

**87. Insulating Properties of the Aluminium Anode Film and its Application** (Japanese). Tsunetarō KUJIRAI and Akira MIYATA. [Bull. Inst. Phys. and Chem. Researches, Tōkyō, V., 6 (1926), 439-510, with fig.]—The authors studied the electrical insulating properties of aluminium anode film prepared electrolytically by a new method (Bull. Inst. Phys. and Chem. Researches, Tōkyō, V., 8 (1926), 489-516.) and some applications of the same.

(1) Formation procedure: As electrolyte, 2% aqueous solution of oxalic acid is used. Both electrodes are of aluminium, the anode being the sample to be treated. In spite of its high critical voltage, the resistance of the film is low enough when in the electrolyte, to pass sufficient current under moderate voltage and the formation of the film continues very much longer than with any other electrolyte which has ever been proposed. Volt-ampere characteristics, thickness and weight of film are measured as the functions of electricity passed through. As the results of microscopic and X-ray investigations, the structure of the film is confirmed to be of crystalline nature.

(2) Electrical properties: Dielectric strength is about one-third or half that of mica. During two months its strength did not deteriorate. No failures were observed up to about 300°C. Dielectric constant is not so high as imagined in the case of aluminium cells and is about 6. Volume-resistivity is  $6.0\text{--}7.5 \times 10^{12}$  ohms/cm.<sup>3</sup> at 16°C., and at 200°C. it shows a little rectifying action. Its dependence on temperature and relative humidity is studied. Surface-resistivity and moisture absorption from surrounding atmosphere as a function of relative humidity are also studied.

(3) Applications: (a) Electric heater:—As supporter of heat element a treated aluminium block was used. Due to high thermal conductivity of the latter, the temperature distribution is more uniform than with ordinary heater. (b) Pole-transformer:—With treated aluminium winding its overload capacity was increased even in air. No troubles on account of oil temperature rise. Good space factor. (c) Induction motor:—Stator coils of 5 H. P. cage motor were wound with treated aluminium. Good slot space factor. High overload capacity. Tested without damage in film up to the temperature at which solders of cage-rotor melted and sprang away. Authors.

**88. Thermoelectric Wattmeter** (Japanese). Shōji SETOH and Akira MIYATA. [Bull. Inst. Phys. and Chem. Research, Tōkyō, V., 7 (1926), 574-579, with fig.]—A new, simple direct-reading thermoelectric wattmeter suitable for measurement of small power is described. Its essential part consists of two heating wires (constantan dia. 0.025 mm.) each stretched in front of 250 thermo-junctions arranged in a straight line, the distance apart between them being adjusted to within 0.3 mm. The circuit is essentially the same as was used by Urwin, the only difference being that adjustable resistances are placed in series and parallel to the heating wire which is furthest from the load. By means of two independent adjustments of the said resistances, the difference between the heat developed in the two heating wires is made proportional to the power measured. This difference is read by a d'Arsonval galvanometer (voltage sensitivity  $7.35 \times 10^{-6}$

volt/mm.) connected to the thermo-junctions. The thermo-junctions consist of a thin constantan wire (dia. 0.025 mm.) wound on an ebonite bobbin with 1 section (numbers of turns 250) and gold plated half way through its whole length in a still bath. Thus the gold film deposited on the wire short-circuits the resistance of the core metal and the junctions lay in a straight line on each side of the bobbin, affording a handy form of differential thermo-junctions connected in series. The whole system is enclosed in a metal vessel. Theory of the adjustments for the proportionality between the deflections of the galvanometer and the power to be measured at any power factor and wave form is given. The most convenient means of adjustments is to adjust the resistances connected to the heating wire, so as to nullify the galvanometer deflection at open circuit and short circuit of the load terminals. The sensitivity procured 140 mm. per watt with the shunt of 200 ohms and multiplier 5,000 ohms agrees very well for low power factor (tested down to 0.1) and high frequency (tested up to 500 cycles). The time-lag is few minutes.

Authors.

**89. Preparation and Chemical Properties of the Aluminium-Oxide Film** (Japanese). **Tunetarō KIJIRAI** and **Sakae UEKI**. [Bull. Inst. Phys. and Chem. Research, Tōkyō, V., 8 (1926), 591-597, with fig.]—After brief historical sketches, prominence which the new electrolytic method gives to the use of a suitable aluminium film as heat resisting-insulating materials is described in which an aqueous solution of oxalic acid is used as the electrolyte. Informations on the best conditions for the operation are given as follows:—Concentration, 2%. Formation-voltage, continuous current 100 volts. Current density, about 0.1-0.3 amperes/cm.<sup>2</sup> Bath temperature, the lower the better. Stirring, indispensable. Duration, one or two hours (depends on thickness required). Then chemical reactions of film formation are discussed in some detail, and the physical and chemical properties of film are described. Chemical composition of the film is concluded to be the same as that of diaspor (Al<sub>2</sub>O<sub>3</sub>·2H<sub>2</sub>O) which occurs in a natural state.

Authors.

**90. Relation between Dielectric Loss in Fibrous Insulating Materials and the Temperature** (Japanese). **Yotsuo TORIYAMA** and **Shōzō YOSHIDA**. [Bull. Inst. Phys. and Chem. Researches, Tōkyō, V., 9 (1926), 617-627, with fig.]—The authors describe the relation between temperature and dielectric loss in fibrous insulating materials at a constant relative humidity. According to the authors' experimental results, the quantity of moisture absorbed in the insulating materials decreased gradually with the temperature rise at a constant relative humidity, but this decrease was very small especially in the case of low relative humidity. The authors measured the dielectric loss at a constant relative humidity of 0%, 36.5% and 47.5% in the range of 20–70°C. The effect of the temperature rise upon the loss was proportionately greater to the relative humidity.

Authors.

**91. Balancing Network for Telegraphic Purposes** (Japanese). **Kan-ichi OHASHI**. [J. Teleg. and Telep. Eng. Japan, 56 (1926), 504-515, with fig.]—The writer shows a method of theoretically determining the balancing network, which is applicable only to land lines of telegraphic circuits. For shorter lines, he proposes a very simple method and at the same time very rigorous. By expanding the expression of sending-end impedance in the following manner

$$\beta_0 = Z_0 \tanh \gamma l = Z_0 \left( \gamma l - \frac{\gamma l^3}{3} + \frac{2}{15} \gamma l^5 - \frac{17}{315} \gamma l^7 + \frac{62}{2835} \gamma l^9 - \dots \right),$$

he obtained favourable equivalent forms of networks. For longer lines, he suggests the use of a ladder-type network with meshes of different lengths; its unbalance currents are attributed to wave reflections at the junction points of meshes. The writer's opinion is that when the wave reflection at each junction point can contribute equally to the unbalance current at the sending-end, the balancing network is most favourably constructed. Finally, on the assumption of certain conditions the writer proposes the use of 3-mesh network with sectional length ( $S_1$ ,  $S_2$  and  $S_3$ ) having such proportions as

$$S_1 : S_2 : S_3 = 1 : 2 : 4.$$

Author.

**92. On Alternating and Rotating Magnetic Fields** (Japanese). **Tetsutarō MIYAZAKI**. [Tech. Jour. Kyūshū Imp. Univ., I., 4 (1926), 183-194, with fig.]—Using double Fourier series, the author deals with alternating and rotating magnetic fields of various kinds as composed of elementary travelling magnetic waves.

Author.

**93. Abnormal Electric Current Phenomena in Electrolytic Solutions between Two Unequal Electrodes** (Japanese). **Genki SADAKEYO** and **Kazuo HIROSE**. ["Denki-Hyōron," XIV., II and 12 (1926) 1056-1062 and 1117-1124, with fig.]—When an E. M. F. of several volts or so is impressed upon an aqueous solution of any acid or base by means of two cylindrical metallic electrodes of different radii, put side by side or one being interior to the other hollow one, the current makes abnormal changes with the lapse of time, depending not only upon the polarity and the magnitude of the applied E. M. F., but also upon the sorts of the electrolytes, their concentrations, and the kinds of electrode metals. Even when the commercial distilled water is used as an electrolyte, the current changes abnormally.

Authors carried out some experiments, using a pair of wire and hollow cylindrical electrodes of platinum and of copper. When an aqueous solution, with the concentration of one to one several-hundredth of a normal, of NaCl, HCl, or KOH is taken as the electrolyte, the electrodes being platinum, the current after impressing the E. M. F. decreases by and by the more dilute the solution the more rapidly; and the current when the anode is of the larger diameter, is always larger than when the polarity of the E. M. F. is reversed. At higher degree of dilution, the relation of magnitude between the currents depending upon the polarity of the applied E. M. F. remains the same for KOH, but becomes reversed for HCl. The current in NaCl solution at such higher dilution takes some complex variation. The currents in HCl or KOH solutions at higher dilution are also not smooth.

Each of the current-characteristics of solutions of HCl and KOH, described above, seem to be the general ones for all acids and bases respectively, organic or inorganic they may be.

The theories for these phenomena have not yet been decided.

Authors.

**94. Thermal Characteristics of the Surrounding Wall of an Electric Furnace in a Steady State** (Japanese). **Tsunezō KAWASAKIYA**. ["Denki-Seikō" II., 4 and 5 (1926), 133-143 and 153-160, with fig.]—The author starts from the assumptions that the isothermal surfaces are all parallel and the density of the thermal or



electric current across the isothermal surface is uniform, and proceeds to deal with the thermal differential equations of a composite wall, its inner zone being considered to be passed by an electric current.

The author introduces a geometrical quantity which he calls geometrical resistance and expresses by a hyperbolic function, and thus the solution of the differential equations is obtained with no assumptions except the above mentioned ones.

He also gives some integral quantities which are useful for the evaluation of the thermal energy stored in the composite wall.

Finally the mathematical expressions are represented by a graph which leads us to a conception with regard to the thermal valve action of the conducting hearth.

Author.

**95. *The Measurement of Internal Electrostatic Capacities of Triode Vacuum Tubes*** (Japanese). Yasushi WATANABE and Tatsu NARITA. [J. I. E. E. Japan, 451 (1926), 209-214, with fig.]

**96. *On the Performances of a Transmission System with Three-Winding Transformers*** (Japanese). Mitsuru MASHIKO. [J. I. E. E. Japan, 452 (1926), 241-266, with fig.]

**97. *On the Time-Lag Measurement of the Spark between Electrodes of various Shapes*** (Japanese). Matsunosuke IWATAKE. [J. I. E. E. Japan, 453 (1926), 406-409, with fig.]

**98. *On the Sudden Short-Circuit Phenomena of a Single-Phase Alternator*** (Japanese). Yasujirō FUKUCHI. [J. I. E. E. Japan, 459 (1926), 1213-1232, with fig.]

**99. *The Temperature Distribution on the Bulb Surface of Incandescent Vacuum and Gas-filled Tungsten Lamps*** (Japanese). Masaie HORIOKA, Tadashi SATŌ and Ken-ichi YAMAMOTO. [J. Ill. Eng. Soc. Japan, X., 6 (1926), 259-265, with fig.]

**100. *On the Uniformity of Foreign-made Receiving Tubes*** (Japanese). Kanya ONO. [Researches, Electrot. Lab. Japan, 168 (1926), 1-45, with fig.]

**101. *Leakage Current from the Return Circuit of Electric Railways*** (Japanese). Masaie HORIOKA. [Researches, Electrot. Lab. Japan, 183 (1926), 1-24, with fig.]

## MINE ENGINEERING (1—18).

1. *Size of Mineral Particles in Flotation Process and Floatability of Mixed Sizes* (Japanese). **Kichirō YAMAGUCHI**. [Nihon-Kōgyōkwaishi, Ser. XLII., 489 (1926), 26-51, with fig. and tables.]—The author describes an investigation on the sizes of mineral particles to be treated in flotation, particularly on floatability and mode of floating of the mixed sizes, and influence of minute particles on coarse particles and vice versa. He experimented with both film-flotation apparatus and froth-flotation machine, using for convenience some coal as a sample.

From the results of the experiments the following items are summarized:—

(1) The maximum size of a floatable coal particle by film flotation is about 1 cm.<sup>3</sup>; this coincides with the calculated value.

(2) Floatability by film flotation rises up to nearly 100% with coarseness of particles till the maximum size above mentioned is arrived at, but descends with fineness of particles.

(3) The ash-reduction, however, is imperfect when the size of particles becomes coarser.

(4) By froth-flotation, the most suitable size for both recovery and quality, is classed under the figures, 65, 150, 48, 100 and 200 mesh (order of favourability). Too fine (—200) or too coarse (+28) particle is unfavourable.

(5) The sufficiently suitable mixtures are as follows: (100+150), (150+300), (65+150), (48+65), (48+100), (65+100), (65+200), (35+100), (100+200), (35+48), (35+65), (35+150), the range of sizes being 35-200 mesh.

(6) The coarser and the finer are affected by each other: generally speaking the finer acts on the coarser so badly as to make it less floatable, but the coarser on the finer to break the flocculent cloud in the pulp and make it more floatable. In a particular case, however, coarse and less floatable particles are made to float by most favourably conditioned finer-particles.

(7) Some practical possibilities in flotation can be deduced from the results; for example, the length of the floatation machine should be determined by not only the capacity required but also the time of duration for the completion of floating, which is characterized by the nature of the particles; or by whether a more close sizing of flotation feed is to be required or not, etc.

Author.

2. *Determination of the Angle of Friction of Broken Coal* (Japanese). **Hidenosuke SANO** and **Seiichi HIGUCHI**. [Nihon-Kōgyōkwaishi, Ser. XLII., 490 (1926), 110-114, with fig. and a table.]—Angle of friction of coal—samples of different sizes, wet or dry—on a wooden, iron rubber, and concrete chute are determined in several manners.

Authors.

3. *Effects of Bends in the Gallery on the Propagation of Coal Dust Explosion* (Japanese). **Hidenosuke SANO**. [Nihon-Kōgyōkwaishi, Ser. XLII., 492 (1926), 247-250, with fig. and a table.]—The possible effects of bends and junctions of branches of underground roadways upon the propagation of coal dust explosions are investigated, being analyzed into two functions; the effects upon the propagation of shock

waves; and the cooling actions upon the explosion flame. Some experiments conducted with a small gallery (20 cm.  $\times$  17 cm.) show that:—

(1) On passing a T junction the violence of the shock of explosion which travels into the right-angle branch is about a half that of the shock which travels directly on. The distribution of the intensity of shock in a cross-section of the gallery at T junction is characteristic.

(2) The ratio of the intensity of direct-rush to that of back-rush, where these rushes are propagated from the same original explosion, can vary according to different positions in the roadway, with reference to its bends and branches.

(3) The addition of a blind roadway in the direction of movement of the explosion at bends or junctions of branches of roadways, is effective in checking the travelling of the shock, as far as it is necessary, in length.

(4) The cooling action of bends or junctions of branches fails either to extinguish the explosion flame or to cause its preferential propagation in one branch. Author.

**4. A Study of the Blasting of Rocks** (Japanese). **Hidesaburō AOYAMA.** [Nihon-Kōgyōkwaishi, Ser. XLII., 493 (1926), 363-396, with fig., phot. and tables.]— This paper describes the theory of rock blasting together with the experimental results of blasting in limestone. The author measured the modulus of elasticity and Poisson's ratio for 6 cubic cm. specimen and calculated the velocity of the wave of dilatation after blasting is done.

The author discussed the value of the index of blasting (Zeiger der Mine) proposed by the previous investigators, and summarized the data concerning the quantity of explosives required to blast one cubic metre of rocks.

The temperature and pressure developed during the blasting were obtained, and the thermal conductivity was measured by Tadokoro's apparatus, giving the values of 0.00560 and 0.00531 for the temperature 650°C. and 830°C. respectively. The author calculated coefficient of expansion of limestone and found to be 0.00000798 for every 1°C. He stated that for laminated rock the part where heat is applied is especially expanded when heated the direction of stratification, and expanded uniformly when heated in the direction perpendicular to the lamination. T. O.

**5. Causes of Spontaneous Combustion of Coal** (Japanese). **Jitarō YONEZAWA.** [Nihon-Kōgyōkwaishi, Ser. XLII., 494 (1926), 465-478, with fig. and tables.]— The author investigated the spontaneous combustion of coal from Hokkaidō, Kyūshū and Formosa, and made the examinations of the above mentioned samples with reference to (1) the chemical composition of coals, (2) the absorption of oxygen by coals and the influences of pyrites, (3) the extracts and residues of coal by using pyridine as the solvent and (4) the relation between spontaneous combustion and moisture of coal.

From the results of these experiments it is concluded that the causes of spontaneous combustion in coal not only depend upon the geological conditions of the coal seam, the ventilation of the mine and the mode of working seam, but notably, on the nature of the coal. The friable and finely crushed coal, the coal with finely divided pyrites and the one with higher percentage of the extract by pyridine, are effective to raise the temperature by their oxidation. Moisture in coal under 100°C. is favourable to a rise in temperature of the coal which is a bad conductor of heat and liable to decompose pyrites. Besides this, much liquor and much hydrogen gas from the low temperature carbonization of coal, seem to have some effective influence upon spontaneous combustion. Author.

**6. The Compression-Test of Coal** (Japanese). **Hidenosuke SANO** and **Shigemi TADERA**. [Nihon-Kôgyôkwaishi, Ser. XLII., 495 (1926), 558-565, with fig. and tables.]—The crushing strength of Japanese bituminous coal (Tertiary formation) is 340 kg./cm.<sup>2</sup> in average, its compression 1.3% in average, and its average hardness 83 (Shore's number). The relation of strength of coal to its chemical composition and the size of underground coal pillars are discussed. Authors.

**7. Adsorption of Gas on Mineral Particles with Special Reference to the Flotation Process** (Japanese). **Jôgorô OKADA**. [Nihon-Kôgyôkwaishi, Ser. XLII., 496 (1926), 601-615, with fig. and tables.]—The author measured the amount of the gas adsorbed on the various kinds of minerals and gangue materials by automatic mercury pump which is the newest type devised by Beutell and Oberhofer. He did not only recognize much carbon dioxide gas but that other gases were adsorbed on the mineral surface. The gaseous amount which was adsorbed on the minerals was within his experimental error. Author.

**8. Machine-Oil as a Flotation Reagent** (Japanese). **Yukichi YOSHIOKA**. [Nihon-Kôgyôkwaishi, Ser. XLII., 496 (1926), 616-625, with tables.]—The author carried out the experiment in order to investigate the effects of machine-oil as a flotation reagent, and confirmed that by adding machine-oil the floatability of the sulphide ores is strongly increased, and this phenomena is especially noticeable with basic ores than acidic ores.

The sample used was a cupriferous pyrite under 65 mesh, and the M. S. machine was employed for this experiment.

The author concludes that by this method copper-concentrate, pyrite, and gangues are completely separated from the cupriferous pyritic ores; thus the equipment and operation of the mill are simplified, resulting in the increase in extraction and the saving in running expenses. T. O.

**9. On Electrical Prospecting by the Schlumberger Method** (Japanese). **Yoshizô FUJITA**. [Nihon-Kôgyôkwaishi, Ser. XLII., 497 (1926), 673-695, with fig. and tables.]—This paper is the report of the results of electrical prospecting the applicability of which is studied in relation to the deposits in this country.

The writer used the Schlumberger electrical prospecting instrument, and carried out the investigations with the first method of Schlumberger's electrical prospecting, depending on the weak electric current, which is naturally generated by the spontaneous polarization of the orebody in question. Having no spare cups of non-polarizing electrode, he used wooden cups instead of the earthenware ones, and satisfactory results could be obtained by this new type of electrode.

The shape of equipotential lines about the negative center which the writer traced at the Yanahara pyrite mine, are like the contours of a regular round hill. From the lines thus traced and electrical profiles, the writer concludes that the buried orebody is a massive pyritic deposit, similar to that already exploited in the adjoining Yanahara area, and in the eastern part near the river, the orebody has a slightly more steep inclination than the other parts.

The Sekizen and Yokei areas, at the Besshi copper mine and the Muneo mine were also tested. The equipotential charts in this case agrees with the known conditions of the deposits. The curves were, in general, elongated in the direction of the strike of the vein.



It is worth knowing that in the Ashio copper mine, the writer measured over 1,300 millivolts of potential difference

The writer proposes certain problems for further study on this subject and concludes that at the present stage of our knowledge, electrical prospecting has the possibility of measuring wide areas in question simply, economically and rapidly, giving a general view of deposit as an auxiliary to the usual methods of prospecting. Author.

**10. *The Disintegration of Coal by Acids* (Japanese). Hidenosuke SANO and Tarō TOMIYAMA.** [Nihon-Kōgyōkwaishi, Ser. XLII., 497 (1926), 707-709, with fig. and tables.]—Being of the opinion that bituminous coal is intersected by a multitude of microscopic and immeasurable fissures that are filled with material of a composition similar to the calcium carbonates, some experiments with Japanese coal samples have been made to determine the effect of an acid treatment upon the disintegration of coal. A comparative examination of the products of float-and-sink tests of treated (samples of coal, before subjected to mechanical crushing, are warmed with hydrochloric acid) and untreated (crushed simply by mechanical treatment) coal, reveals the fact that with the former separation is cleaner and more clearly discriminated between coal-constituents.

Authors.

**11. *Testing of an Air Compressor* (Japanese). Hidesaburō AOYAMA.** [Nihon-Kōgyōkwaishi, Ser. XLII., 499 (1926), 905-916, with fig. and tables.]—This paper is the report of the results of testing an air compressor installed at the mining laboratory of Tokyo Imperial University. The compressor is of the Ingersoll-Rand Imperial X R B No. 2, 25.4 mm. and 16.5 mm. by 20.3 mm., with a displacement of 2.57 cubic metres per min. of free air at the maximum absolute pressure of 8.7 kg. per cm.<sup>2</sup>.

The author carried out the experiments in determining the index number of the compression curve, distribution of pressure in the air cylinder, losses of volumetric efficiency, and increase of mechanical efficiency at the pressure of 5.25, 5.96, 6.66, 7.37 and 8.08 kg. per cm.<sup>2</sup>.

The conclusions drawn from the experiments by increasing the terminal pressure of air were as follows:—

(1) The index of the compression curve is constant, and the temperature of the compressed air increase with its absolute pressure in the 6th root of the ratio of the discharge and intake air pressures.

(2) The distribution of pressure in both cylinders is more uneven at the lower pressure, and the intercooler pressure approaches to its theoretical value at the terminal pressure of 6.66 kg. per cm.<sup>2</sup>.

(3) Volumetric efficiency decreases gradually, and there is 4.7% difference between the maximum and minimum values.

(4) Mechanical efficiency increases gradually, and there is 4.8% difference between the maximum and minimum values.

(5) Mean effective pressure increases with terminal air pressure, but for the pressure above 6.66 kg. per cm.<sup>2</sup> this is not so noticeable. T. O.

**12. *A Study of Screening Efficiency* (Japanese). Tadashi OYAMA.** [Nihon-Kōgyōkwaishi, Ser. XLII., 499 (1926), 917-933, with fig. and tables.]—The author investigates the size of the "difficult grain" after Warner, which is difficult to pass the screen, being as large as the meshes of the sieve.

An attempt has been made in screening the river sand with the Tyler standard screen; and in reviewing the figures giving in this paper, it is evident that:—

(1) The limiting size of the “difficult grain” for a certain mesh of screen can be determined experimentally.

(2) For a certain amount of the “difficult grain,” screening efficiency is constant and independent of the amount of the coarse or fine grains and their mixtures added.

(3) Screening efficiency is inversely proportional to the amount of the “difficult grain.”

(4) For a certain amount of the under-sized and coarse grains, screening efficiency for the under-size is inversely proportional to the amount of the “difficult grain.”

(5) For a certain amount of the under-sized and coarse grains, screening efficiency for the over-size is inversely proportional to the amount of the “difficult grain.”

(6) Screening efficiency varies with the expression used for even the same sample at the same conditions.

T. O.

**13. Some Problems of Slime Flotation** (Japanese). Mitsujirō ITŌ. [The Suiyō-Kwaishi, V., 2 (1926), 145-159, with fig. and tables.]—The general principles of ore flotation and the effect of slime are discussed. Effects of reagents, time and temperature on settling velocity were preliminarily measured for different copper slime from the Ashio Mine. Then the tests were made with the 5,000 c.c. U. S. machine and the effect of reagents on the extraction and on the change of settling velocity of slime were investigated. Comparative tests of the U. S. and the K and K machine were also made. The following were the chief results obtained:—

(1) By the addition of inorganic reagents the extraction of flotation was inversely proportional to the settling velocity of slime within a certain limit, although this effect of organic reagents was not so simply observed. (2) Potassium xanthate was the most effective reagent and the K and K machine was far superior to the U. S. machine for slime flotation.

Author.

**14. Underground Blasting with Liquid-Oxygen Explosives at the Hitachi Mine** (Japanese). Tomoji SUZUKI. [The Suiyō-Kwaishi, V., 3 (1926), 211-242, with fig. and tables.]—A study of certain fundamental characteristics of liquid-oxygen explosives has been made. Conclusions to be drawn from the author's experiments are as follows:—

(1) As to the explosive power there is no difference between the liquid-oxygen explosive and the Sakura-Brand and with selected cartridges, rather stronger results may be obtained. Although the laboratory tests of the Military Scientific Investigation Institute and the surface experiments in the sand at this mine on the explosion power of the liquid-oxygen explosive showed it to be respectively 50.0% and 20.0% stronger than that of Sakura-Brand, under-ground experiments showed that there was no marked difference between them.

(2) The transportation and handling of the liquid-oxygen explosive is somewhat troublesome compared with the ready-made explosives as gelignite, but may be used conveniently in practice.

(3) As to safety, the liquid-oxygen explosive is far superior to the ready-made explosives and there is no danger except at the time of explosion, besides that, it diminishes the risks of being stolen or of accidents occurring during handling.

(4) From the economical point of view, we can profitably replace the solid explosives with the liquid-oxygen explosive when we use large amounts of the latter. If we study

further the nature of the liquid-oxygen explosive and become skilful in its handling, we may remove the defects of the liquid-oxygen explosive and can use it practically.

Author.

**15. *The Rate of Decline and Life of Oil Wells in Japan*** (Japanese). **Tsunenaka IKI.** [Nenryō-Kyōkwaishi, V., 45 (1926), 615-625, with fig.]—The rate of decline in the oil output of the wells in Japan is generally very regular, and is expressed as a logarithmic curve. The ultimate production and the life of the wells in a field can be estimated by the initial production of an individual well.

The author investigates the rate of production in the Nishiyama, Niitsu, and Kurokawa oil fields, and estimated the average life of wells in those fields to be of 5 to 12 years. By considering the production records of wells in the Takaya and Kurokawa fields, the author showed that the "law of equal expectations" after Lewis and Beal held good at least for a part of those fields.

Several factors are concerned in the rate of declines in oil output, they may be stated by the author as follows:—

- (1) The larger the production, the quicker will be its decline rate.
- (2) The wider the spacing, the slower be its decline rate.
- (3) The smaller the specific gravity of oil and the larger the amount of gas, the quicker will be its decline rate.
- (4) The larger the amount of water, the quicker will be its decline rate. T. O.

**16. *A Study of home-made Electric-Detonators*** (Japanese). **Tomoharu ŌHASHI.** [Saikōyakin-Geppō, IV., 1 and 2 (1926), 11-15 and 35-38, with tables.]—This paper is a preliminary report on electric-detonators made in this country, the object of the study being to ascertain the causes of mis-fires occasioned when detonators are arranged in series.

When direct or alternating current is passed through the connecting wires, the platinum wire bridge is heated to a temperature corresponding to the intensity of the current, the bridge resistance, the time, and others. Of these the factors influencing the mis-firing are the resistance of the bridge wire, the intensity of the current and duration.

(1) Platinum wire bridge. The bridge wire is of a platinum-iridium alloy, and the diameter is in most cases 0.02-0.03 mm. and 5-6 mm. in length. The bridge resistance is, then, 0.94-1.72 ohms. The variation depends upon the difference of the length and the diameter, and even when platinum wires of the same length and diameter are used, the resistance varies greatly according to their properties. So in connecting many detonators in series, to make them simultaneously fire, it is necessary to pick up only those of the same quality and the same resistance.

(2) The effect of solder. This is to show that the firing conditions differ according to the proportions of the constituents of the solder used to connect the bridge wire with bare copper wires.

Several experiments are made with those connected with solder of various proportions of tin and lead, with the result that with the increase in tin, less influence is noted on the resistance, while, the greater the increase in lead the greater the influence. But when tin is in a greater quantity, it is apt to run down into the platinum bridge and shortening the heating surface of the platinum wire, makes it necessary to take more time in firing, that is, necessitates stronger electric current to be transmitted, while, where lead is prevalent, a comparatively low current is enough to work.

(3) The effect of the current on the bridge. A stronger electric current is needed for many detonators connected in series than for one detonator to be fired. According to his own experiment, for 10 detonators the required ampere is 1.0; for 20, 1.2 amp.; for 30, 1.33 amp.; for 50 detonators 1.5 amp. The amperage, however, is uncertain, according to the property of the platinum bridge, the state of soldering, and mode of contact of the wire bridge with the powder.

With alternating and direct currents, experiments have been carried out respectively, with the result that it makes no difference.

The author concludes that it is of great help toward minimising mis-fires to connect many electric detonators in series and make them simultaneously fire, strictly avoiding the use of different kinds of platinum wires, picking up only those of the same resistance, and to make the contact of platinum bridge with igniting powder as complete as possible.

Author.

**17. Tunnel Blasting at the Taikosan Mine, South Manchuria** (Japanese). **Hidesaburō KURUSHIMA**. [Anzan-Tekkōkwai-Zasshi, II., 20 (1926), 993-1006, with fig., phot. and tables.]—Tunnel blastings have been done twice at the Taikosan mine in 1926. In each case a small adit (1 m. × 1 m.) has been driven at the foot of a bank about 20 metres high, and at the end of the adit a level has been driven at right angles with the main. Chambers are made at the ends of the level.

For the determination of the blasting charge, the following formula is used:—

$$W = CL^2H$$

where  $W$  denotes quantity of explosive in kilograms,  
 $L$  „ length of least resistance in metres,  
 $C$  „ coefficient depending on the nature of rock and explosive,  
 $H$  „ the height of bank in metres.

The experience on the drill blasting in which the charge is about 50 kg. at one time shows that the coefficient  $C$  should be about 0.7 and more or less. And 8 to 10 tons of ore are obtained by 1 kg. of gelignite.

At first, the Cordeaux Bickford was used as principal method of detonation and the electric method as an auxiliary. Since, only the electric method has been used.

In both blastings banks have crumbled perfectly up to the line expected, but at first there were found comparatively many big pieces which must be blasted by block holding. So, having charged a little more explosive ( $C=0.7$ ), there were only a few big pieces left but most of them were of suitable size for handling without secondary blasting.

Particulars concerning the cost of blasting are given.

Author.

**18. On a New Process of Gaining Pure Zirconium Salt From Zirconium Ores.** **Kōzō TABATA** and **Shizuta MORIYAMA**. [Researches, Electrot. Lab. Japan, 172 (1926), 1-21.]—The authors decomposed the zirconium ore with concentrated  $H_2SO_4$  and deposited basic zirconyl sulphate from it. Its empirical formula was determined as  $8. ZrO_2, 7. SO_3$ .

This amorphous precipitate was treated with HCl of suitable concentrations, and the deposited precipitate was found to have an empirical formula  $2. ZrO, 1. SO_3, 5. H_2O$ , which had no trace of iron. It was manifested that by repeated treatments with HCl of suitable concentrations only a trace of  $TiO_2$  would remain in the basic zirconyl sulphate deposits.

It is pointed out that the authors' method is very simple in operation and that better results in purity of products and in efficiency are obtained.

Authors.



## METALLURGY (1—61).

**1. Occlusion of Gases by Metals and Alloys in Liquid and Solid States** (Japanese). **Keizō IWASÉ.** [Tetsu-to-Hagane, XII., 1 (1926), 35-54, with fig.]—The author determined the solubilities of hydrogen, nitrogen, carbon monoxide and dioxide in the pure metals Fe, Cu, Sn, Sb, Al, Zn and in the alloys such as pig, silumin, and bronze under one atmospheric pressure and at various temperatures by a modified Sievert's apparatus and came to the following conclusions: (1) The solubilities in the liquid state are much greater than those in the solid state, and their temperature coefficients differ according to these states. (2) Solubilities increase as the temperature rises, except in the case of CO and CO<sub>2</sub>. (3) Hydrogen is dissolved in Fe, Cu, Zn, Sb, Sn, Al, cast iron, silumin, and bronze. (4) Nitrogen is dissolved in Fe, Cu, Al, silumin, and cast iron but not in Zn, Sn, and Sb. (5) CO and CO<sub>2</sub> are dissolved in Fe, Cu, and cast iron but not in Zn, Sn, and Sb. (6) The temperature coefficients of the solubility of hydrogen in pure iron differ according to the  $\alpha$  and  $\gamma$ -states of the metal.  
H. S.

**2. Investigation of Iron-Sands** (Japanese). **Kumahiko HASEGAWA.** [Tetsu-to-Hagane, XII., 2 and 3 (1926), 97-151, and 221-276, with diag., fig., pl. and tables.]—The author collected 107 samples of iron-sands from chief locations and studied their physical and chemical properties, especially the case of occurrence of titanium. After many experiments, he determined the constituents of iron-sands as pure magnetite, magnetite-dissolving ilmenite, parallel growth of magnetite and ilmenite, pure ilmenite, rutile, hematite, limonite, silica sand and other gangue minerals. Titanium in the ore was observed to be partly reduced by magnetic separation but not all. As the results of the semi-industrial test with 5,730 tons of weathered iron-sand containing 25 per cent. of iron in average, at Noushi, Shimokitagun, Aomori prefecture, the author gives the following conclusions:—

By electric process it is more easy to smelt iron-sands than by the blast furnace one, but it cannot be used at present on account of the high price of electric power in Japan. As to the blast furnace process it is hopeless that the whole charge of iron-sands may be smelted, but probably safe workings from an economical point of view, if they are mixed with ordinary ore, limiting TiO<sub>2</sub> content in the charge to less than 3%. Japanese iron-sands would be sintered after magnetic concentration and smelted in blast furnace by mixing with ordinary ore, which is most economical at present.  
Author.

**3. The Fatigue of Steel and its Recovery** (Japanese). **Yutaka FUJII.** [Tetsu-to-Hagane, XII., 2 (1926), 152-176, with diag., fig., phot. and tables.]—The author investigated the fatigue of different kinds of steel, followed by physical and chemical phenomena, the recovery condition of fatigue steel, the nature of fatigue, and the theory of fatigue.

The following conclusions were drawn from the author's experiments:—

(1) Steel is embrittled by the repetition of heavy stress beyond a certain value, and becomes very fragile to shock but recovers its own toughness through a suitable re-heat treatment.

(2) Resilience of steel to shock is considerably lowered through the repetition of stresses but the tensile properties are not so affected seriously and rather improved near the limit of proportionality and breaking strength.

The slipping occurs in the crystals themselves and also at their boundaries due to the repetition of stresses, slipping and dislocation take place between steel and slag particles, if the latter are disseminated in the former.

(3) Electric resistance of steel increases very slightly through the repetition of stresses but decreases again by re-heat treatment.

(4) Remnant magnetism of steel was measured after every P. B. N. (10%) and was observed to decrease step by step, but this tendency not only disappeared but also sometimes the opposite tendency appeared after the period when the incipient crack was suspected to occur.

(5) The highly stressed portions of the specimen are likely to be more electro-positive than the low stressed part, but this phenomenon disappears if the specimen is suitably re-heat-treated.

Author.

**4. Some Investigations on Tempered Steel** (Japanese). **Tokujiro MATSU-SHITA**. [*Tetsu-to-Hagane*, XII., 2 (1926), 177-188, with fig. and tables.]—By means of a high temperature torsion apparatus, the yielding temperature of steel at various torsional stresses was measured and it was observed that there exists a one-to-one correspondence between the stress and the yielding temperature. The critical yielding temperature, which was obtained by extrapolation and would correspond to no stress, was about 500°C. for carbon steel, and 550°C. for Ni-Cr steel; these were called the yielding temperature of the respective steels.

From the above result we may deduce the following fact: the internal stresses in steel, whatever their origin, must be released gradually during heating and the state of complete removal be obtained at the yielding temperature.

The variation of the magnetic hardness  $H_m$  of tempered steels was examined, and found an abnormal increase of the magnetic hardness in the temperature- $H_m$  curve at the vicinity of the yielding temperature. The author explained that the increase of  $H_m$  is due to the disintegration of the strained grain by the intercrystalline slipping associated with the releasing of the internal stress; it is the author's view that the yielding temperature is a very important one in considering the behaviour of strained crystals under heat.

Author.

**5. An Investigation of Cast Iron** (Japanese). **Hiromu TANIMURA**. [*Tetsu-to-Hagane*, XII., 3 (1926), 277-301, with fig., phot. and tables.]—This paper consists of four parts. In the first part the author determined the critical temperature of graphitization and showed that graphitization occurs only when molten metal reaches the eutectic temperature and that complete graphitization takes place only below the eutectoid point.

In the second part he prepared 41 kinds of specimens, whose carbon content varies from 2.1 to 3.6% and silicon from 0.24 to 4.88%. Specimens were cooled at various rates of cooling from 18 to 1.5 degrees per second. From these results he constructed a cast-iron diagram in which 3 kinds of domains are shown; i.e. the domain of perfect gray cast iron, perfect white cast iron, and intermediate cast iron (chilled cast iron).

In the third part microscopic examinations are dealt with. In the fourth part

mechanical tests are made and the suitable contents of carbon and silicon to give the high tensile cast iron are shown.

Author.

**6. *A Study of Moulding-Sands in Japan*** (Japanese). **Tokushichi MISHIMA.** [Testu-to-Hagane, XII, 4 (1926), 338-383, with fig., phot. and tables.]—The present investigation was undertaken to study the physical and chemical properties of all kinds of moulding-sands which have been used in this country and to show how these properties have an effect upon the casting-products, and at the same time to standardize the testing methods of moulding-sands.

The following results may be summarised:—

(1) From the results of chemical analysis and sizing tests, the sands for steel casting may be classified into five kinds and those for iron casting into eight kinds; their merits and demerits were discussed as compared with the sands in foreign countries.

(2) The permeability and bonding strength were measured by the special apparatus and showed how these properties were influenced by the water-content, grain size and shape, clay-content and degree of ramming.

(3) By means of a dye-adsorption test, the author measured the quantity and quality of clay substances which have important effects upon the bonding strength of moulding-sands, and found that there exists an important relation between the dye-adsorption value and the bonding strength.

(4) The influence of heating upon the properties of moulding-sands was also examined and it showed that bonding strength and dye-adsorption value decrease rapidly in the temperature range from 400 to 500°C. and this change may be taken as the result of dehydration of the constitutional water in clay.

(5) The temperature distributions in dry and green-sand moulds were determined by the temperature measurements in the mould after molten cast iron was poured in.

(6) The refractoriness of all kinds of moulding-sands was measured and the influence of iron oxide and clay upon it was also determined.

Author.

**7. *The Sintering of Powdered Iron Ores in a Reducing Atmosphere*** (Japanese). **Gaichi YAMADA.** [Tetsu-to-Hagane, XII, 5 (1926), 431-452, with fig., phot. and table.]—The magnetic concentrates of the Anshan Iron Works, South Manchuria, containing 61.60% of total iron and 13.95% of silica, were sintered with various carbonaceous fuels and 8% moisture at different temperatures and observed the sintering and melting phenomena. The chemical and microscopical investigation of the sintered and melted cake were made and the comparison among the sintered ores from iron and steel works of various countries was also tried. The chief experimental results are as follows: (1) the concentrates without a carbonaceous fuel, do not melt at 1,350°C., but those having a carbonaceous fuel melt at about 1,180°C. (2) The melting temperature of the concentrates with moisture is slightly lower than that of those without moisture. (3) It is better to sinter the concentrates at the temperature as near as its melting temperature. (4) The sintering in a reducing atmosphere with some moisture is far better than that in a oxidizing atmosphere. (5) 3 to 5% coke or anthracite powder is suited as the carbonaceous fuel used in the sintering. (6) A fusible eutectic of ferrous orthosilicate and ferrous oxide is formed and acts as a binder of the concentrates.

Author.

**8. *A Study of the Smelting of Japanese Iron-Sands*** (Japanese). **Shichizō UMEZU**. [Tetsu-to-Hagane, XII, 7 (1926), 612-621, with diag., fig. and tables.]—An experiment was carried out by the author to investigate the various physical properties of iron-sands; such as melting point, fluidity, viscosity, specific gravity, and colour of slags in which titaniumoxide was added intentionally in various percentages. Many favourable conclusions were drawn from his experiment in applying a mould specially devised for the casting of slags. Generally the percentage increase of titanium oxide to some extent decreases the melting points, lowers the coefficient of viscosity, deepens the bluish colour of fracture, and easily becomes to be crystalline. He also determined the suitable limit of the titanium-oxide content in slag to melt Japanese iron-sands by referring to the results of former investigators. Author.

**9. *On the Segregation and the Subcutaneous Blowholes of the Carbon-Steel Ingot and their Effect on the Defects of Hot-Rolled Steel, and the Killing of the Steel*** (Japanese). **Genji ŌISHI**. [Tetsu-to-Hagane, XII, 8 (1926), 663-700, with fig., phot. and tables.]—This paper consists of three sections, i.e. the segregation, the blowholes and the killing of the steel.

(1) The Segregation. The author classifies the segregation of the carbon steel into the central segregation (or the ordinary segregation) and the local segregation (i.e. the ghost, the spot segregation, etc.), and considers the causes of the segregation, the methods for the prevention of the segregation, and the bad effect of the sonims for the segregated steel. Several practical examples for the defects of the hot-rolled steel caused by the segregation are shown.

(2) The Blowholes. The author states the existence of blowholes in the steel ingot from the practical point of view, and classifies the blowholes in the mild-steel ingot. The methods for prevention of the shallow-seated subcutaneous blowholes are discussed, and several practical examples of the defects of hot-rolled steel caused by subcutaneous blowholes are shown.

(3) The Killing of the Steel. The author considered the mechanisms of two kinds of killing operations, i.e. killing by the deoxidiser and "natural killing," and concludes that they are nearly identical except that the killing action by the deoxidiser proceeds more rapidly compared with the natural killing. The author compares the deoxidising powers of the common deoxidisers with respect to the dissociation pressure of the deoxidised products (or oxides). Author.

**10. *On the Properties of Chilled-Roll*** (Japanese) **Kohei TANIGUCHI**. [Tetsu-to-Hagane, XII, 10 (1926), 808-839, with fig., phot. and tables.]—Various properties of chilled-rolls in the plate mill of the Imperial Steel Works, Japan, were investigated. The results are summarised as follows:—

(1) Tables of chemical composition and working results of plate rolls broken in the year 1925 are shown.

(2) A large chilled roll in the plate mill (dia. of body 750 mm. length of body 2,000 mm.) was cut down to study precisely the distribution of T.C., G.C., C.C., Si, Mn, P, S, Cu, Cr, and Ti. Except G.C. and C.D. all elements are almost uniformly distributed throughout the body, no marked segregations of S and P compared with cast-steel rolls was found.

(3) Macro and micro-structures were investigated. Explanations of the special form of



white cast-iron eutectics in a chilled part and of the mechanism of graphitisation were also given.

(4) Distribution of hardness and the practical method of confining the depth of chill were shown, and annealing of chilled parts till 500°C. for 48 hours did not give any notable effect on hardness only releasing the internal stress in them, but impact hardness at an elevated temperature was remarkably reduced by slight heating.

(5) In precise dilatometric researches in vacuo the chilled part showed a slightly smaller expansion than the grey part up to 600°C. but quite the opposite above this temperature.

(6) Tension, compression, torsion, impact, alternate stress, wear at room temperature and also tension and bending tests at high temperature were carried out. The tensile strength at a high temperature decreased markedly above 500°C.

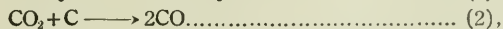
(7) Various defects and their causes in the practice of manufacturing and using the roll were also discussed.

Author.

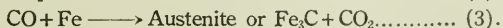
**11. On the Relation between the Mechanical Properties of Steel and its Annealing Temperature.** Nenosuke KOBAYASHI. [Tetsu-to-Hagane, XII., 10 (1926), 840-844, with tables.]—The author annealed different kinds of steel for 3 hours at various temperatures from 600°C. to 900°C. and tested their mechanical properties in order to find the most suitable annealing temperature. The specimens were always taken from a round ingot 6½" thick. The results showed that the elastic limit, tensile strength and Brinell hardness decreased gradually to a minimum value at a critical temperature adjacent to the  $A_{c1}$  point in every case, as the annealing temperature was raised above 500°C. These values, however, increased, as the temperature was further raised, while on the other hand elongation and impact figures changed with the annealing temperature just the reverse direction as above. It is concluded that temperature adjacent to the  $A_{c1}$  point of a steel is the most suitable temperature for its annealing.

H. S.

**12. On the Cause of Increase of Carbonisation Velocity with Carbonates** (Japanese). Gensuke TAKAHASHI. [Tetsu-to-Hagane, XII., 10 (1926), 845-866, with fig. and tables.]—It is a well-known fact that when some carbonate is added to charcoal or coke, their effectiveness as carburizing agents is very much increased. This action has hitherto been considered to be due to the reduction of the carbonate with subsequent formation of carbon monoxide, which acts as the carburizing agent, according to the following scheme



and



This theory was made untenable by the following results of the author's experiments.

(1) When iron or steel is heated with carbon, the carburization is more energetic in the presence of the carbonate than in a brisk current of carbon monoxide.

(2) The carbonate increases the carburization velocity even when there is no dissociation.

(3) When the carburization is carried out in a current of CO, the presence of the carbonate remarkably accelerates the velocity of carburization even in the absence of solid carbon.

A new substitute for this theory, that this increasing effect is due to the reaction of the carbonate separating nascent carbon from carbon monoxide, which is capable of react-

ing upon iron and steel very easily, is now proposed, based upon the author's experiments, the correctness of which being further supported by the following facts:—

- (1) The carbonate is very effective in separating carbon from carbon monoxide.
- (2) The velocity of carburization is correspondingly larger the greater the amount of nascent carbon which comes in contact with the surface of iron or steel.
- (3) The pressure of any substance which acts, liberating nascent carbon from carbon monoxide, increases the velocity of carburization.
- (4) Under a condition such that the nascent carbon separated from carbon monoxide recombines easily with carbon dioxide, the energizing effect upon carburization is not remarkable.
- (5) The effect of carbonate is of such a nature that it does not show itself in an atmosphere which contains carbon monoxide.
- (6) Nascent carbon easily penetrates into iron and steel.

Author.

**13. Some Investigations on Chilled-Iron Plates** (Japanese). **Chōhei ASADA**. [Tetsu-to-Hagane, XII, 11 (1926), 905-937, with fig., phot. and tables.]—The author investigated the influence of the thickness of chill plate and its temperature, the maximum temperature of the melted cast iron, the casting temperature and the melting time etc., upon the effect of chill and the hardness of chilled parts, under the condition of the definite composition. The temperatures of chill plates were varied from room temperature to about 400°C. and the higher the temperature, the lower the effect of chill. The depth of chill was increased with the thickness of chill plate, but when its thickness was over about 67% of that of the test piece, the effect was negligibly small. Casting temperature ranged from 1,200°C. to 1,400°C. and the result was that the effect of chill increased with the temperature rise, and this coincided with Irresberger's opinion. The maximum temperature was also similarly influenced and with a more remarkable effect than the above. The duration of melting has not affected so much. Generally, it was observed that the greater the depth of chill, the higher the hardness of chilled part. In this experiments, the depth of chill was determined by the three methods, namely (1) the observation of fracture of test piece, (2) the change of depth-hardness curve on that section, (3) the measurement of the specific gravity of the test piece. The third one is a new method found in our investigation and if we know the specific gravity of the grey part and the white of one sample respectively, we can determine the depth of chill of the other sample of the same composition by the following equation.

$$h = l \frac{D - D_g}{D_w - D_g}$$

where  $h$  = the depth of chill,

$l$  = the thickness of the casting,

$D$  = the specific gravity of the casting,

$D_w$  = the specific gravity of the white part,

$D_g$  = the specific gravity of the grey part.

Author.

**14. A New Phenomenon concerning the Graphitization of White Cast Iron and its Application to the Manufacture of Black-Heart Malleable Castings** (Japanese). **Daikichi SAITŌ** and **Hiroshi SAWAMURA**. [Tetsu-to-Hanage, XII, 12 (1926), 1006-1036, with fig., phot. and tables.]—The authors studied the influence of heat treatment before annealing of white cast iron upon its graphitisation, and found a

new phenomenon to the effect that white cast iron becomes very unstable when it is hardened. Microscopical study was also made as a supplementary work. From the results obtained from their experiment, the authors confirmed that the crushing effect of a great abnormal expansion of the structure mixing with cementite which is due to the martensitization of austenite on cementite crystals as the principal cause of the new phenomenon. Further experiments on the application of the new phenomenon were carried out, and the following conclusions were drawn:—(1) White cast-iron castings of a simple form can be safely quenched in water, if they are slowly heated before quenching. (2) They can be quenched very safely in rape-seed oil. (3) The tensile strength of the annealed test bars, which was quenched in water or in oil before annealing, is greater than that of the test bars annealed in the present practical operation, but the elongation of the former is liable to be somewhat inferior to that of the latter.

Authors.

**15. *The Roasting of Copper Pyrites* (Japanese). Keinosuke HIRAKOSO.** [Nihon-Kôgyôkwaishi, Ser. XLII., 491 (1926), 202-220, with fig. and tables.]—With special reference to the hydro-metallurgical extraction of copper from sulphide ores, the author treats of the draft roasting of copper pyrites in an electric tube-furnace at the temperature ranging from 50° to 750°C. with an accuracy of reading of about 1°C. The extraction of copper and iron by leaching and the change of weight after roasting, are systematically studied. After discussing the phenomena of roasting in some detail, he points out the characteristic feature of the mode of formation of various compounds and their reactions occurring in the course of roasting.

Author.

**16. *The Roasting of Iron Pyrites* (Japanese). Keinosuke HIRAKOSO.** [Nihon-Kôgyôkwaishi, Ser. XLII., 492 (1926), 259-278, with fig. and tables.]—This paper deals with the leaching test by water and then by dilute sulphuric acid in the draft roasting of iron pyrites, and also the determination of the change of weight and the desulphurization. The author describes the mode of extraction and the reactions. He points out, from the theoretical aspect, the systematic formation and decomposition of various compounds such as  $\text{FeS}$ ,  $\text{Fe}_2\text{O}_3 \cdot 2\text{SO}_3$ ,  $\text{Fe}_2\text{O}_3 \cdot \text{SO}_3$ ,  $\text{FeSO}_4$ ,  $\text{Fe}_2(\text{SO}_4)_3$ ,  $\text{FeO}$  and  $\text{Fe}_2\text{O}_3$  and shows their quantitative analytical curves and equilibrium chart in the course of oxidation.

Author.

**17. *Formation of Water-Soluble Copper in the Roasting of Cupric Oxides with Iron Pyrites* (Japanese). Keinosuke HIRAKOSO.** [Nihon-Kôgyôkwaishi, Ser. XLII., 493 (1926), 397-398, with a fig. and a table.]—It is shown that in the draft roasting of cupric oxides with iron pyrites, the formation of water-soluble copper is increased by the addition of iron pyrites, and that the cupric oxides can easily be converted fully to copper sulphate by the proper treatment.

Author.

**18. *Thickness of Charges in the Roasting of Copper Pyrites* (Japanese). Keinosuke HIRAKOSO.** [Nihon-Kôgyôkwaishi, Ser. XLII., 496 (1926), 630-641, with fig. and tables.]—With special reference to the thickness of charges the author treats of three different cases of tests on the draft roasting of copper pyrites. Plotting the curves for extraction and change of weight, he shows the special influence of varying thickness on desulphurization and sulphatization as well as oxidation.

Two different effects on the progress of oxidation are enumerated and studied. (1) The

oxidizing action of air enclosed between the pyrite particles. (2) The oxidizing action of air passing over the charge, which proceeds inwards from the surface of the charge.

Author.

**19. Time for Roasting and Order of Reactions** (Japanese). **Keinosuke HIRAKOSO**. [Nihon-Kôgyôkwaishi, Ser. XII., 499 (1926), 934-943, with fig. and tables.]—The author describes the phenomena which occur in the roasting of copper pyrites as the time goes on, especially in the starting period of roasting. He carried out the experiment in an electric furnace at the temperature of 500°C., exposing the samples to the current of air at respective intervals of time for the purpose of comparison.

Measuring the amount of extraction of copper and iron in the leaching test, he recognised clearly the following order of reactions during the experiments:—(1) acid-soluble iron, (2) acid-soluble copper, (3) water-soluble iron and (4) water-soluble copper.

Author.

**20. Variation of Specific Resistance of Wire by Annealing, and the Conditions which reduce the Specific Resistance to a Minimum** (Japanese). **Masaharu GOTÔ**. [Nihon-Kôgyôkwaishi, Ser. XLII., 500 (1926), 1009-1023, with fig. and tables.]—The author discussed theoretically the variation of specific resistance of wire by annealing and deduced the conditions which reduce the specific resistance to a minimum.

It is concluded that (1) when cold drawn wire is so annealed, as its internal tension disappears almost entirely without causing any recrystallization, the specific resistance is reduced to a minimum; (2) the minimum specific resistance is smaller if the drawing degree is larger, but however there is a certain limit, beyond which the drawing degree has but a little effect; (3) the annealing temperature and its duration, which reduce the specific resistance to a minimum, differ with different kinds of metals as well as drawing degree.

Author.

**21. The Influence of Small Quantities of Various Metals on the Nature of Aluminium Alloys, Part IV** (Japanese). **Takayasu HARADA**. [The Suiyô-Kwaishi, V., 1 (1926), 13-28, with diag. and phot.]—The author showed here the equilibrium diagrams of Al-Cu, Al-Si, Al-Ni, Al-Mn, Al-Fe, Al-Mg, Al-Co, Al-Zn and Al-Sn, especially a very minute portion of aluminium sides up to 5% of other elements. He also gave short descriptions and micrographic illustration on each diagrams.

Author.

**22. The Influence of Nickel upon Aluminium Silicon Alloys, Part II** (Japanese). **Chûyô HISATSUNE**. [The Suiyô-Kwaishi, V., 1 (1926), 52-57, with fig., phot. and tables.]—The constitutions of the alloys containing Al, Si and Ni were determined by means of thermal analysis and microscopical study, and the author found a ternary eutectic point at 560°C. on the alloy containing 3% of Ni and 11% of Si.

The hardness of these alloys at a higher temperature was also measured by a drop-hammer hardness tester, and the alloys containing 10-13% of Si and 0.5% of Ni were observed to maintain hardness at a room temperature up to 300°C.

Author.

**23. The Properties of Electrolytic Copper Sheets, Parts I and II** (Japanese). **Shingo SONODA**. [The Suiyô-Kwaishi, V., 2 and 3 (1926), 91-103 and



263-271, with fig., phot. and tables.]—This investigation was undertaken to find the method of the manufacture of copper sheets by electrolysis without melting, but merely annealing and rolling after studying the physical properties of the sheets in question. In the first part Erichsen values of electrolytic sheets, influence of annealing of electrolytic sheets and ordinary rolled sheets on their hardness and Erichsen values, and the influence of rolling direction on the mechanical properties of electrolytic sheets are described.

In the second part the effect of the percentage reduction in rolling on the mechanical properties of electrolytic sheets and of the annealing temperature on rolled sheets are described.

H. S.

**24. The Influence of Aluminium on the Properties of Bearing-Metals** (Japanese). **Gosaburō YAHAGI**. [The Suiyō-Kwaishi, V., 2 (1926), 110-118, with fig., phot. and tables.]—Babbit metals and white metals rich in Pb containing 0.5 and 1.0% of Al were prepared, and their compressive strength, abrasion properties and hardness were examined. From the results of experiments the author concluded that the addition of a small quantity of Al had a marked influence upon the properties of these bearing-metals, and the alloys containing 0.5% of Al showed in all respects the properties better than those containing 1.0% of Al.

Author.

**25. The Age-Hardening and Heat-Treatment of 60-40 Brass** (Japanese). **Naoo ICHIKAWA**. [The Suiyō-Kwaishi, V., 2 (1926), 119-130, with fig., phot. and tables.]—The hardness and compressibility of commercial 60-40 brass at high temperature were measured and a sudden change of hardness and compressibility was observed to occur at about 590°C. and 600°C. respectively.

The phenomenon of ageing was found in the quenched 60-40 brass, and the change of hardness and tensile strength at various temperatures was measured. The hardening was observed to be accelerated by re-heating at a lower temperature.

Author.

**26. On the Properties of Case-Hardening Steel and its Case-Hardened Parts** (Japanese). **Michitomo ISHIZAWA**. [The Suiyō-kwaishi, V., 3 (1926), 176-210, with fig., phot. and tables.]—The experiments were carried out to observe the physical and mechanical properties of case-hardened steel and the following remarks are given:—

Part I. Case-hardened steel.

(1) Velocity of the carbon penetration immediately becomes constant, the terminal values being as follows:—

Temperature.	Ac <sub>3</sub>	Hyper Eutectoid. mm./hour.	Total. mm./hour.
900°C.	+ 25°C.	0.025	0.125
1,000	+ 125	0.075	0.175
1,100	+ 225	0.125	0.325

(2) The temperature has more influence on the penetration of carbon than the duration of heating.

(3) Grain sizes correspond to carburizing temperatures.

(4) Perfect refining of the carburized steel cannot be performed without heating above the Ac<sub>3</sub> point.

(5) Grain growth corresponds to temperature above Ac<sub>3</sub> point.

(6) Perfectly refined grains can be obtained after refining and hardening.

- (7) High impact value can be obtained at the low case hardening temperature.  
 (8) Hardening at a temperature between  $A_{c1}$  to  $A_{c3}$  after carburization, high impact value can be obtained in quenching at a high temperature.  
 (9) To obtain the best result the author recommends the following heat treatment after carburization:—

Oil quenching at	$A_{c3} + 30^{\circ}\text{C.}$
Water quenching at	$A_{c1} + 20^{\circ}\text{C. to } A_{c1} + 30^{\circ}\text{C.}$

Part II. Carburized part.

- (1) Hardness of carburized part becomes a maximum at 0.9% or more in carbon contents.  
 (2) Hardness of the case-hardened part decreases by tempering above  $200^{\circ}\text{C.}$   
 (3) As the carbon content of the cemented layer falls off during the heating for refining and hardening, special care must be taken to prevent the falling off of carbon content.  
 (4) Primary hardening, or refining is necessary to decrease the amount of free cementite, and refining temperature must be at  $A_{cm}$ , or slightly above it.

Part III. Case-hardened machine parts of aero-engine.

Author.

**27. *The Fatigue of Steel and its Recovery, Part III*** (Japanese). **Yutaka FUJII**. [The Suiyō-Kawishi, V., **3** (1929), 272-290, with fig., phot. and tables.]—The results of the experiments on the repeated bending and repeated torsion tests are given and the condition of recovery of the fatigue caused by the repeated bending is shown in diagrams. H. S.

**28. *An Investigation on the Alloy System of Aluminium Copper and Zinc, Part I*** (Japanese). **Hideo NISHIMURA**. [The Suiyō-Kwaishi, V., **3** (1926), 291-304, with fig., phot. and tables.]—The constitution of Al-Cu-Zn alloys on the Al-Zn side was investigated by differential thermal analysis, microscopical study, etc., and the equilibrium diagram was determined. In this investigation, the peritecto-eutectic reactions at  $385^{\circ}\text{C.}$ ,  $400^{\circ}\text{C.}$ ,  $425^{\circ}\text{C.}$  and  $590^{\circ}\text{C.}$  were found to exist, as believed by some investigators, but the reaction,  $\text{liquid} + \text{CuAl}_2 \rightleftharpoons \text{CuAl} + (\beta)$  at  $418^{\circ}\text{C.}$ , was not observed; instead of it a new peritecto-eutectic reaction,  $\text{liquid} + \text{CuAl}_2 \rightleftharpoons (\text{Al}) + \text{CuAl}$ , was found.

The  $\beta$  solid solution in Al-Zn system was found experimentally to transform in two steps with the reactions,  $(\beta) + (\epsilon) \rightleftharpoons \text{CuAl} + (\text{Zn})$  and  $(\beta) + \text{CuAl} \rightleftharpoons (\text{Al}) + (\text{Zn})$ , in the ternary system.

The age-hardening properties of Al-Cu-Zn alloys rich in Al were also examined, and a complicated reaction was found to exist between age-hardening and the composition of the alloy. Age-hardening was considered to be due to the spontaneous crystallisation of solute phase in a super-cooled solid solution. As to the mechanism of hardening, the author considered that the separation of the second phase or phases accompanying with the disintegration of the lattice of solvent gave rise to hardening on one side, and on the other, internal strain produced in the crystals, owing to the rapid change of lattice construction.

Author.

**29. *Investigations on Chilled Castings*** (Japanese). **Kojirō HOMMA**. [Kinzoku-no-Kenkyū, III., **2** (1926), 96-117, with fig. and phot.]—Molten cast iron was cast in an iron mould and the Shore scleroscope values were measured on the outer, the

middle, and the central portion of the cross section of the casting in order to study the various influences upon the chilling effect. The principal facts observed are as follows: (1) The higher the temperature of the molten bath, the greater the chilling effect. (2) The chilling effect is indifferent to the casting temperature, if the highest temperature of the molten bath is the same. (3) The higher the highest temperature of the molten bath, the greater the chilling effect, if the casting temperature is the same. The degree of this effect is almost equal to that of the temperature of the molten bath. These phenomena are also observed on the cast iron cast in sand mould. (4) The longer the duration of time, in which the temperature of the molten bath is maintained, the greater the chilling effect. The effect in question, however, is far smaller than that of the temperature of the molten bath. (5) The phenomena mentioned above are all explained by Honda and Murakami's gaseous theory on graphitization in cast iron. (6) The effect of the temperature of iron mould is not remarkable. (7) The thicker the wall of the iron mould, the greater the chilling effect. (8) The effect of the temperature of the molten bath on the chilling effect of the white cast iron cast in an iron mould or in a sand mould is small. (9) The carbon content of the casting is almost indifferent to the effect of the highest temperature of the molten bath. (10) As the silicon content decreases, the effect of the highest temperature of the molten bath becomes somewhat remarkable. H. S.

**30. On the Determination of the Density of Cementite** (Japanese). **Toyozō ISHIGAKI**. [Kinzoku-no-Kenkyū, III., 3 (1926), 169-175, with fig. and tables.]—The densities of different kinds of carbon steel and cast iron were measured and the corrections of the impurities present in these specimens applied; by extrapolating the straight line representing the relation between the density and the carbon content to the region of the concentration of cementite, the density of this carbide was found to be 7.662. Author.

**31. On the Volume Change in Cast Iron during Solidification, with a Criticism of the Double Diagram of the Iron-Carbon System** (Japanese). **Kōtaro HONDA** and **Hikozō ENDŌ**. [Kinzoku-no-Kenkyū, III., 3 (1926), 176-184, with fig. and tables.]—With the object of confirming the view that in the iron-carbon system, graphite formed during the solidification is a decomposition product of cementite, but not the product of a direct precipitation from the melt, the authors measured the change of volume of different cast irons during solidification by means of a thermo-balance. These cast irons contained nearly the same amount of carbon, and different amounts of silicon, and hence showed different degrees of graphitisation.

According to the result of observation, as the graphite carbon found in the solidified specimen decreased, the observed change of volume varied from a positive value to a negative one. From the graphite curve, the volume change in the case of no graphitisation was estimated to be -3.6 per cent. On the other hand, if we admit that the graphite present in these cast irons is a decomposition product of cementite, we can calculate the volume change due to the decomposition of cementite from the quantity of the graphite present, and hence the actual change of volume is found by the relation:—

$$-\frac{\partial v}{v} = -3.6 + \text{volume change due to the decomposition (\%)}$$

The coincidence between the calculated and observed values is very satisfactory, showing the correctness of the view referred to in the beginning. Authors.

**32. On Malleable Cast Iron and the Mechanism of its Graphitization** (Japanese). **Tario KIKUTA**. [Kinzoku-no-Kenkyû, III., 4 (1926), 185-224, fig., phot. and tables]—By using a dilatometer, measurements have been made of the amount of the graphitization, which took place on keeping the test specimen at a constant high temperature, as is done in practice when white cast iron was annealed in the malleable-iron foundry, and the progressive degree of this reaction was examined microscopically afterwards.

The summary of the author's results are as follows:—

(1) In the investigation of graphitization of white cast iron for obtaining black-heart malleable cast iron, it is desirable to carry out the graphitization in two stages.

(2) In order to graphitize white cast iron completely, it is essential that after the completion of the graphitization of the free cementite at a high temperature above the  $A_1$  point, the article should be heated just below the  $A_1$  point for a prolonged time or cooled very slowly from the  $A_1$  range to decompose the eutectoid cementite.

(3) The graphitization of the first and second stages are greatly affected by the annealing temperature, and the time required to complete them decreases logarithmically with the rise of temperature.

(4) There is an intimate relation between the thickness of the casting and the size of the free cementite, i.e., the size of the free cementite grows as its thickness increases; and the graphitization of the free cementite will become more difficult as its size becomes larger or the casting thicker.

(5) The tapping temperature of the melt also affects the graphitization of white cast iron and the graphitization becomes more difficult as the temperature is raised.

(6) Silicon has a powerful effect on the graphitization of the first and second stages, and as this content is increased, the time required to complete the graphitization logarithmically decreased.

(7) For the second stage of graphitization, carbon is more effective than silicon, although it hardly affects that of the first stage.

(8) The action of manganese is to lessen the graphitization, the effect being particularly great on that of the second stage, so that it is very important to limit its contents to below 0.5 per cent. in the case of the black-heart malleable iron casting.

(9) The action of sulphur like that of manganese is to hinder the graphitization, especially that of the second stage, and in practice it is advisable to limit its content to 0.6 per cent.

(10) Phosphorus assists the graphitization in the first stage but for that of the second stage, its contents must not exceed 0.3 per cent.

(11) The rapid heat-treatment of a practical sample has been tried and it was possible to obtain black-heart malleable cast iron by heating white cast iron containing more than 2.5 per cent. of carbon and one per cent. of silicon for fifty-four hours.

(12) Black-heart malleable cast iron makes a growth with repeated heating and cooling through the  $A_1$  transformation range as a grey cast iron does; and the cause of this phenomenon is almost the same as in the case of grey cast iron.

(13) The mechanism of the graphitization of white cast iron is that by means of the catalytic action of free carbon oxides present in the casting, a nucleus of the graphitizing temper carbon is formed principally along the boundary of the cementite, and the graphitization, which is to take place successively, is accelerated by the affinity between the iron and the included elements.

Author.



**33. On the Specific Heat of Carbon Steel** (Japanese). **Saburō UNNO.** [Kinzoku-no-Kenkyū, III., 4 (1926), 225-246, with fig. and tables.]—The heat content of carbon steels at high temperature was determined by the mixture method, while the oxidation of the specimen was prevented by passing a purified hydrogen gas through the furnace. The specimens were twelve kinds of steels with different carbon contents from 0.09% to 2.84% and range of temperature was 23-1,250°C. According to A. Meuthen, the specific heat is constant below the  $A_1$  point, but the present writer showed that the specific heat is only constant above the  $A_3$  point, and that below this point, it increases with the rise of temperature. The quantity of heat for the dissolution of pearlite in iron was determined by measuring the heat content above and below the  $A_1$  point. This heat increases proportionally with the content of carbon, reaches a maximum at 0.9 per cent. and ends at 6.7 per cent. For the dissolution of 1 gr. of carbon in iron, a heat of 1,760 calories is required, while, 16.1 calories are necessary for the dissolution of 1 gr. of pearlite in iron. From the heat content-concentration curve, it was found that, the mean specific heat of cementite increases with the rise of temperature; it is 0.149 at 150°C. and 0.220 at 850°C. It was observed that the specific heat of the carbon poles with 98% C increases almost linearly up to 700°C., and afterwards its rate of increase gradually diminishes. It is confirmed by experiments that the  $A_1$  transformation is a function of temperature and time, but that the  $A_2$  transformation is a definite function of temperature only. From the heat content-concentration curves, the heat of transformation from martensite to pearlite was obtained and found to be proportional to the carbon content. The heat of transformation from austenite to martensite, or that from martensite to pearlite, increases proportionally with the content of eutectoid carbon. The heat of transformation from austenite to martensite for a eutectoid steel amounts to 5.9 calories.

Author.

**34. On the Solubility of Carbon in Pure Iron** (Japanese). **Yukio YAMADA.** [Kinzoku-no-Kenkyū, III., 5 (1926), 294-297, with fig. and tables.]—From the investigation of the specific resistance and micro-structure, the author concludes that the solubility of carbon in pure iron at room temperature is less than 0.01 per cent., if any.

H. S.

**35. On the Hardness of Different Structures in Steel** (Japanese). **Kanji TAMARU.** [Kinzoku-no-Kenkyū, III., 6 (1926), 299-316, with fig., phot. and tables.]—The author determined experimentally (1) the relative composition of carbon and manganese which is just sufficient to obtain austenite by water-quenching, (2) the variation of hardness in carbon, nickel and manganese steel with temperature, (3) the relation of the hardness of quenched steel to its carbon concentration, and (4) the relation between the hardness of quenched carbon steel and the tempering temperature. He found that (1) the hardness of both austenite and martensite in carbon steel at room temperature is 155 and 720 respectively according to the Brinell number, (2) the hardness of austenite in carbon steel was 10 according to the Shore scleroscope value at 820°C., (3) the hardness of strained cementite was 820 and its natural hardness 640 according to the Brinell number, and (4) the hardness of austenite in manganese steel both at ordinary and at high temperatures was 182 according to the Brinell number and 17 according to the Shore scleroscope value respectively.

H. S.

**36. On the Transformation of Retained Austenite into Martensite by means of Stress** (Japanese). **Kōtarō HONDA** and **Keizō IWASE**. [Kinzoku-no-Kenkyū, III., 6 (1926), 326-330, with fig. and tables.]—This paper deals with an interesting fact observed by T. A. Mathews that in the quenching of alloy steels, more austenite will be obtained by oil-quenching than by water-quenching. The experiment by the authors confirms E. C. Bain's idea that the internal stress set up in steel promotes the transformation of retained austenite into martensite by quenching, and this stress being greater in water-quenching than in oil-quenching, more austenite will be transformed into martensite in the case of the former quenching than in the latter, and consequently the anomalous phenomena, which seem to be contradictory to our ordinary belief, will result.

H. S.

**37. On the Mechanical Properties of Low-Carbon Chromium Steel** (Japanese). **Makoto SAITŌ**. [Kinzoku-no-Kenkyū, III., 6 (1926), 331-335, with fig., phot. and tables.]—The author investigated the mechanical properties of the low-carbon steel containing 27.0–28.0% chromium. When the above ratio becomes larger, there is a tendency to decrease its tensile strength, but its elongation and contraction of area seem to be very much improved; especially when it is oil hardened at 1,000°C. and tempered. It is probable that, unless we take the above ratio as more than 28 the cast structure remains and its mechanical properties are not fully refined.

The mechanical properties of the steel with the ratio of 28 are as follows:—

(dia.=5 mm., gauge length=50 mm.)	Tensile strength. kg./mm. <sup>2</sup>	Elongation. %	Contraction of area. %
In forged state	70.3	10.6	53.6
Oil hardened at 1,000°C.	65.2	20.0	59.2
Oil hardened and tempered at 900°C.	64.8	21.2	64.0

In Brinell hardness there is no great difference in cast, forged and heat-treated state, but in the last state, it seems to become somewhat softer. In stainless property, it showed a good result.

Since this alloy steel shows no change of microscopical structure up to 900°C., it is probable that its mechanical properties suffer no great change in such a high temperature; and since its machining is very easy, the author believes that to some extent it is a suitable material for turbine blades.

D. S.

**38. On the Distribution of Hardness of Carbon Steel and on Quenching-Cracks** (Japanese). **Tsutomu KASE**. [Kinzoku-no-Kenkyū, III., 8 (1926), 377-384, with fig. and a table.]—The author quenched the specimens of carbon steel having different carbon content and cubic or cylindrical form in water or in oil and measured the hardness at different positions of the quenched specimens. He also studied the phenomenon of age-hardening of hardened steel and observed the relation between the quenching temperature, the size of specimen, the carbon content, the difference in hardness at the edge and at the centre of the hardened specimens, and the occurrence of quenching-cracks.

H. S.

**39. Investigations on Light Alloys for Casting** (Japanese). **Kiyoshi TAKAHASHI**. [Kinzoku-no-Kenkyū, III., 9 (1926), 456-464, with fig. and tables.]—

Tensile strength, elongation, contraction of area, hardness and specific gravity, of various Al-base light alloys, i.e. Al-Cr alloy, Al-Co alloy, Al-Mn alloy, Al-Ni alloy, Al-Cu alloy and Al-Mg alloy, were studied.

H. S.

**40. On the Heat of the  $A_2$  and  $A_3$  Transformations of Carbon Steel** (Japanese). **Saburō UNNO**. [Kinzoku-no-Kenkyū, III., II (1926), 527-533, with fig. and tables.]—By the differential calorimetric method, the heat contents of carbon steels containing 0.040%, 0.135%, 0.270%, 0.350% and 0.770% C were measured at high temperatures. From these results, the mean and true specific heats were deduced, and also found that the  $A_2$  and  $A_3$  transformations in pure iron took place in the representative ranges of about 130° and 40°C. The heat of the former transformation is about 3.65 calories, and of the latter is about 5.35 calories. In carbon steel, both these transformation points descend with carbon content. The  $A_3$  transformation, being a very slow change, vanishes in the eutectoid steel.

Author.

**41. On the Hardness caused by Quenching Steel at Temperatures below the  $A_1$  Point** (Japanese). **Yukio YAMADA**. [Kinzoku-no-Kenkyū, III., II (1926), 537-538, with fig.]—The author confirmed the fact observed by T. Sugiura that when carbon steels are quenched at a temperature below their  $A_1$  point their hardness increases and also the fact that the steels under such condition have not the properties of age-hardening.

H. S.

**42. On the Effect of Porosity upon Thermal Conductivity, Diffusibility, and Heat Capacity at High Temperatures.** **Yoshiaki TADOKORO**. [Sci. Rep. Tōhoku Imp. Univ., Ser. I., 15 (1926), 567-596, with fig.]—Contents:—(1) Introduction. (2) Determination of the porosity and permeability of the specimens to be treated in this work. (3) Change in weight and length by heating the specimen at a temperature up to 1,300°C. (4) Effect of porosity on thermal expansion. (5) Effect of porosity on the crushing strength and spalling tendency. (6) Effect of porosity on thermal conductivity, diffusibility, and heat capacity at high temperatures.

The conclusions drawn from the present investigation are as follows:—

- (1) Porosity varies similarly to gas permeability.
- (2) Diatomaceous earth should be heated at 1,100°C. in order to be used as an insulating material at a high temperature.
- (3) Both thermal expansion and crushing strength decrease, as the porosity of the material increases.

The effect of porosity on these constants can be expressed by a curve resembling a rectangular hyperbola.

(4) A porosity of about 37-38% is the minimum point in the diffusibility, conductivity and heat capacity curves.

(5) Diatomaceous earth is one of the best insulating materials occurring in nature; its porosity is much greater than that of Specimen No. 5 and its crushing strength is very low.

(6) The relation between porosity and spalling tendency can be approximately expressed by a rectangular hyperbola, and porous material can generally resist spalling. Furthermore, as the porosity deviates from 37-38%, the spalling tendency is much affected by it.

(7) A material denser than 37% in porosity does not seem to resist the spalling, when it is subjected to a rapid change in temperature. Again, it is also evident that too

porous material cannot resist crushing. In manufacturing fire-bricks such as magnesia and silica bricks which are liable to spall, the presence of this critical porosity is specially to be noticed.

(8) The term  $\alpha \times (\text{crushing strength})/h$ , where  $\alpha$  is the expansion coefficient and  $h$  the square root of thermal diffusibility, proposed by the present writer to express the spalling tendency is in accordance with practical experience that a porous material can generally resist spalling.

Author.

**43. On the Relation between Hardness, Micro-structure and Specific Resistance of High-Speed Steel** (Japanese). **Katsumi INOUE**. [Tech. Jour. Kyûshû Imp. Univ., I, 2 (1926), 77-82, with fig., phot. and tables.]—The test pieces used in the present investigation were of the following compositions:—

No.	W	Cr	C	Si	Mn	P	S	V
I	19.70	1.10	0.45	0.18	0.15	0.03	0.01	—
II	22.00	6.88	0.75	0.50	0.90	tr.	tr.	—
III	18.50	3.65	0.65	0.25	0.40	0.02	0.02	0.84

After quenching these specimens at temperatures of 1,000°C., 1,100°C., 1,150°C., 1,200°C., 1,250°C., 1,300°C. respectively, Brinell's hardness was measured, giving the highest hardness number 665 in I (quenching temperature 1,200°C.,) 641 in II (quenching temperature 1,300°C.) and 754 in III (quenching temperature 1,500°C.). From these results, he concluded that the most suitable quenching temperature of the high-speed steel employed was at 1,200-1,300°C., showing the micro-structures of various specimens.

Specific resistance of No. III (dia. 8 mm., length 130 mm.), which previously heated at various temperatures for 5 minutes and quenched in oil, was measured in its 100 mm. length. The results showed that the specific resistance increased proportionally with the maximum temperature. This fact agreed with the increase in hardness of the same specimens.

If the quenched specimens were tempered at 600°C. for 30 minutes, specific resistance decreased as compared with the above results.

Author.

**44. Influence of Melting Temperature on the Graphitization of Cast Iron** (Japanese). **Hiromu TANIMURA**. [Tech. Jour. Kyûshû Imp. Univ., I, 3 (1926), 135-140, with fig., phot. and tables.]—The author used pure synthetic cast iron having a composition of T. C. = 3.21%, Si = 1.38%, and very small amount of other elements. He melted 50 gr. of the metal in an atmosphere free from oxidizing action, keeping each specimen at several temperatures from 1,612° to 1,32°C., for 10 minutes. After the molten metal had cooled to 1,250°C., he quenched the crucible containing the metal into a mercury bath and recorded the temperature fall with a thermo-couple. Thus he found the cooling speed of the metals after solidification to be about at the rate 8.00 degrees per second.

He analysed the quantity of total carbon and graphite carbon of each sample and showed the relation of the melting temperature and the graphitization degree,  $\frac{\text{graphite carbon}}{\text{total carbon}} \times 100$  in a diagram.

From this experiments he found that this cast iron undergoes an abrupt change of its property of solidifying as a gray cast iron at about 1,490°C.; if the metal be superheated above this temperature, it is liable to solidify as a white cast iron and below this tempera-



ture this solidifies as a gray cast iron in spite of such a rapid cooling as 8 degrees per second.

He examined the micro-structure of the specimens and concluded that nuclei of graphitization are rapidly absorbed at this temperature and the metal becomes difficult to solidify as gray cast iron.

Author.

**45. *Magnetic Concentration of Weathered Iron-Sands after Magnetic Roasting*** (Japanese). **Toshio MURAKAMI** and **Kumahiko HASEGAWA**. [Seitetsu-sho-Kenkyûsho-Kenkyû-Hôkoku, VI., 2 (1926), 1-22, with fig. and tables.]—The authors investigated the special methods to concentrate weathered iron ores from Shimokitagun, Aomori Province, and Kunohegun, Iwate Province after magnetizing roasting. A revolving tube made of quartz was inserted in an electric furnace which was specially constructed for the present purpose. Ores were charged from one end of the tube and discharged from the other, where coal gas and carbon-monoxide gas were introduced for reduction. The most effective temperature for this purpose was determined as 700°C. The iron recovery by the magnetic concentration of the roasted ores was distinctly raised as high as 85-92%, while in the case of raw ores was only 46%.

Authors.

**46. *On the Bending Motion of Rails during Cooling*** (Japanese). **Saburô UNNO** and **Katsujirô ITÔ**. [Seitetsu-Kenkyû, 92 (1926), 144-150, with fig. and tables.]—It is recognised that alternate bending occurs during the time when a rail is subjected to the finishing roll and then its temperature falls to the room temperature. To discover the cause of this phenomenon, the temperature of a rail at various portions was observed by thermo-couples, and found that the rate of cooling of a rail differed considerably in its cross-section. So the authors calculated the change of length of a rail with time from its expansion-coefficient, which proved to be well agreed with the above motion. From this fact, we may conclude that the bending motion is due to the different rate of cooling.

Authors.

**47. *Preparation of Metallic Cerium by Fused Electrolysis, and the Casting of Pyrophosphoric Alloy*** (Japanese). **Masakichi ÔYA**. [Rep. Imp. Ind. Research Institute, Ôsaka, VII., 4 (1926), 1-30, with fig. and tables.]—The material "cerous oxalate" was the residue obtained after the extraction of thorium-nitrate from the monazite as the by-product of the gas-mantle industry. This oxalate was readily converted into oxide by igniting at 700°-800°C. and this oxides was dissolved in hydrochloric acid. Dehydration of the dydrated cerous chloride was carried out by ammonium chloride method. The cathode of the iron plate was inserted in the electrolysis cell (magnesia crucible) from the bottom, whilst the anode (carbon rod, 1" dia.) was dipped in the electrolyte from the above. The electrolyte was a mixture of 85% cerous chloride and 15% potassium and sodium-chlorides, and electrolysis was carried out at 820°-840°C. Under these conditions, current efficiency was 32%, and yielded 33%.

Pyrophoric alloy (Fe 35%, Ce 65%) was cast in the form of 1/8" dia., 7" length by using a vacuum mould.

Author.

**48. *On the Preparation of Low-Carbon Semi-Steel*** (Japanese). **Masayasu HORIKIRI**. [Rep. Imp. Ind. Research Institute, Ôsaka, VII., 5 (1926), 1-68, with fig., phot. and tables.]—The author prepared various kinds of semi-steels by direct melting in a

cupola. He carried out several important tests on them, viz., tensile, annealing, sliding-abrasion and metallographical tests, and confirmed that the low-carbon and comparatively high-silicon semi-steel has a good distribution of small graphites and is superior to other kinds of semi-steels in every respect.

He furthermore investigated the desulphurizing action of manganese in semi-steels and found the fact that the manganese content has a great effect on the desulphurizing of semi-steel even at the same melting conditions.

Author.

**49. *Effect of Organic Addition-Agents on the Electrolytic Deposits of Zinc*** (Japanese). **Hirota SATŌ**. [Hokkô, 22 (1926), 11-24, with fig., phot. and tables.] — To investigate the effect of organic addition-agents on the structure of electrolytic deposit and especially on the cathode current efficiency, the author carried out the experiment of electrolytic deposit of zinc from sulphate solution using insoluble anode. According to the chemical composition, the agents used are classified into 7 groups, and before electrolyzing, the colloidal or crystalloidal nature of each solution was examined in the ultramicroscope, or tested by the biuret reaction.

The result of electrolyses conducted under the same conditions shows that the agents in one group have a tendency to give nearly the similar effects, while alkaloids give the greatest effect, and proteins and amyloses belonging to carbohydrates come next in the degree of influence. In general, the agent, which produces considerable change on the appearance of the deposit, causes poor results in current efficiency; for this reason, alkaloids and proteins are not considered to be the suitable addition-agents for the deposition of zinc. Amyloses, however, shows fairly good efficiency with a smooth adherent deposit.

It has been usually stated that the colloidal particles suspended in a gelatin solution differ in their size according to whether the solution is boiled or soaked only; in the author's experiment, however, such a difference cannot be observed, and further there is no difference between two deposits obtained from solutions of different treatment. It is also experimentally proved that the views of previous investigators, attributing to the hydroxyl radical of phenols and to amino acid of proteins as the essential functions of these addition-agents, are both incorrect.

Author.

**50. *On the Influence of Physical Properties of Various Quenching Liquids upon the Quenching Effect of Steel*** (Japanese). **Seijirō SHIMURA**. [Sci. Rep. Akita Mining College, 3 (1926), 86-120, with fig., phot. and tables.] — The author measured the specific gravity, specific heat, thermal conductivity and viscosity of various liquids, and investigated the influence of these properties and their temperature upon the quenching effect of steel. The results are summarized as follows:— (1) The cooling power of the liquid may become greater as the specific gravity increases. This is probably due to the fact that the specific gravity has a value corresponding to the other properties such as specific heat or thermal conductivity which have a direct relation to the heat-absorbing or conducting action. (2) The cooling-power of the liquid nearly corresponds to the specific heat with some exceptions. (3) The cooling-power of the liquid is nearly parallel also to the thermal conductivity. (4) The cooling-power of the liquid is, in general, lower when its viscosity is higher. (5) The cooling-power of the liquid becomes smaller as the temperature of the liquid at the moment of quenching of the steel is above a certain temperature.

Author.

**51. On the Reducing Power of  $H_2$ , CO and  $CH_4$  on Anshan Hematite Ore, Part I** (Japanese). Yosei SUZUKI, Masaage MITA and Saburō ASAWA. [Anzan-Tekkōkwai-Zasshi, 12 (1924), 1-17, with fig., phot. and tables.]—In an electric furnace, 100 gr. of hematite ore from Anshan in South Manchuria was heated in the current of  $H_2$ , CO and  $CH_4$  reduced at a constant velocity of 1 litre per hour.  $700^\circ C$ . was adopted as the reduction temperature from the practical point of view. The gases in the reduction tube were withdrawn every hour for analysis and the progress of the reduction of the ore was examined.

The principal features of the results obtained are as follows:— (1)  $H_2$  and CO reduce  $Fe_2O_3$  to  $Fe_3O_4$  and even to FeO or Fe at  $700^\circ C$ . (2) After the reduction of  $Fe_2O_3$  to FeO is completed, the reduction power of  $H_2$  seems to be greater than that of CO. (3)  $CH_4$  rapidly reduces  $Fe_2O_3$  to  $Fe_3O_4$  but hardly reduces the latter to FeO or Fe at  $700^\circ C$ . Hence, it is an ideal reducing agent for magnetic roasting of hematite ore at that temperature. (4) The hard ore from Anshan consisting of hematite and silica becomes very fragile after it is submitted to magnetic roasting.

H. S.

**52. On the Reducing Power of  $H_2$ , CO,  $CH_4$  and Cokeoven Gas on Anshan Hematite Ore, Part II** (Japanese). Masaage MITA. [Anzan-Tekkōkwai-Zasshi, 17 (1925), 635-686, with fig. and tables.]—The apparatus used in this experiments were the same as those used in the previous experiments. In carrying out the experiments, the temperatures  $500^\circ C$ .,  $600^\circ C$ .,  $700^\circ C$ . and  $800^\circ C$ . were chosen and 2, 4, 6, 8, 10, 12, 14 and 16 litres of gases were passed through the ores at each temperature. The speed of the gases passing was one litre per hour. The chief phenomena observed are as follows:— At  $500^\circ C$ .,  $CH_4$  shows the characteristic property that it does not reduce the ore in the lower state than magnetite, while  $H_2$  and CO over-reduce the ore. Cokeoven gas is very good for magnetic roasting at  $500^\circ C$ ., but it shows somewhat over-reduction at the temperatures above  $600^\circ C$ .

Author.

**53. On the Reducing Power of  $H_2$ , CO,  $CH_4$  and Cokeoven Gas on Anshan Hematite Ore, Part III** (Japanese). Masaage MITA and Hideo NAMBU. [Anzan-Tekkōkwai-Zasshi, 18 (1926), 747-785, with fig. and tables.]—In this experiment, the authors measured the reducing power of  $H_2$ , CO,  $CH_4$  and cokeoven gas, which contained water vapour, on the Anshan hematite ore. A water-saturating apparatus was added to the apparatus used in the previous experiment. The reducing gases were first passed through the water-saturating apparatus before entering into the reaction chamber in order to be saturated with water vapour at the temperature inside the vessel. After many experiments, the author found that in every case the water vapour contained in the reducing gas gives negative effects to the reducing power of the gases.

Authors.

**54. On Diesel Engine Castings** (Japanese). Harukichi MATSUURA. [J. Soc. Mech. Eng. Tokyo, XXIX., 106 (1926), 65-89, with fig., phot. and tables.]—The object of this paper is to investigate the essential properties and characteristics of cast iron for Diesel engines, and the author describes some of the results of the tests which have been made on irons of different qualities and composition.

In the first place, some experiments were carried out with a view to determining the cause of decrement of tensile strength of cast iron at elevated temperature, and the author ascribes the causes as follows:—



- (1) Reduction of intercrystalline cohesion of metal.
- (2) Decomposition of pearlite carbide.

From the results of the author's experiments, it was seen that higher tensile cast iron at an ordinary temperature may keep also higher intercrystalline cohesion even at an elevated temperature. It is also clear that the increasing of stability of carbide will retard its decomposition at a high temperature.

One of the principal means of securing high tensile cast iron is to melt a mixture of steel scraps and pig irons; and to secure stable carbide in order to increase manganese content. Thus semi-steel high in manganese may answer to the above two requirements.

It was concluded, as the results of these experiments, that semi-steel rich in manganese may be successfully used for Diesel engine castings.

The allowable amounts of manganese and silicon are shown by an empirical formula.

Author.

**55. *On the Abrasion in Carbon Steel*** (Japanese). **Masuhiko SUZUKI**. [J. Soc. Mech. Eng. Tokyo, XXIX., 109 (1926), 273-297, with fig. and tables.]—First the writer made a study of the relative abrasions of various carbon steels. The test was carried out by means of an abrasion-testing machine newly designed by the writer.

The specimens were taken from Swedish steels in the form of a hollow concentric cylinder specially designed, the content of carbon ranging 0.1-0.9 per cent. The cross sectional surfaces of the two specimen, A and B, were placed opposite each other. The contact surface had the form of a concentric ring.

The abrasion of both specimens was measured by means of a sensitive balance; and by measuring the frictional force at the contact surface, the frictional energy and coefficient of friction was calculated.

Some of the results obtained from the hypoeutectoid steel tested are shown.

Author.

**56. *On the Relation between Wear and Structure in a Carbon Steel*** (Japanese). **Seizō SAITŌ and Takeo MAEOKA**. [J. Soc. Mech. Eng. Tokyo, XXIX., 109 (1926), 299-316, with fig., phot. and tables.]—The authors carried out experiments on the wear of the materials for rolled-steel tyre by the Amsler universal wear-testing machine.

The results of the experiments are as follows:—

- (1) Rolled steel, without any heat treatments, has more resistance to wear than that of sorbitic structure.
- (2) The resistance to wear does not depend solely upon hardness, but also upon the structure of the steel.
- (3) The resistance to wear greatly varies by interchanging the position of the test piece.
- (4) Wear is affected by the steel powders which are let fall by abrasion.

Author.

**57. *On the Relation between the Grain-Growth of Soft Steel and Mechanical Properties*** (Japanese). **Kiyoyoshi YOKOTA**. [J. Soc. Mech. Eng. Tokyo, XXIX., 112 (1926), 481-496, with fig., phot. and tables.]—The author measured the grain-size of mild steels, which were properly heat-treated, by Jeffrie's method, and also



their mechanical properties; that is, tensile strength, hardness and repeated impact test values in order to find the relations between the grain-size and these mechanical properties.

H. S.

**58. *Experiments on the Reaction Velocity in the Reduction of Iron Ores, Part I*** (Japanese). **Sōkichi SUGIMOTO**. [Tetsu-to-Hagane, XII., 6 (1926), 545-556, with fig. and tables.]

**59. *On the Measurement of the Softening Temperature of Clayish Refractory Material for the Determination of their Quality*** (Japanese). **Yoshiaki TADOKORO**. [Tetsu-to-Hagane, XII., 11 (1926), 938-975, with fig., phot. and tables.]

**60. *Mechanical Analysis of Casting-Sands in Japan*** (Japanese). **Kiyondo MATSUZUKA**. [Tech. Jour. Kyūshū Imp. Univ., I., 1 (1926), 31-40, with fig. and tables.]

**61. *On Aluminium Light Alloys*** (Japanese). **Mitsuji ARAKI** and **Takeo MUKAI**. [Bull. Military Arsenal, IV., 3 (1926), 172-202, with fig., phot. and tables.]













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